Solar Possibilities: Electric Pastoralism and the Role of Experimentation in Encouraging Innovation from Tanzania

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Abstract

Solar energy development in Tanzania is steeped in discourses of Western technological transfer whereby the devices themselves are lauded as central innovating agents. In this thesis, drawing from ethnographic work on Tanzania's solar landscape, including 50 unstructured interviews with Maasai pastoralists, city-dwellers of Arusha, Tanzania, and representatives from foreign solar companies, I show how Tanzanians reconfigure incoming solar energy devices through locally-generated knowledges, philosophies, and technologies in calculated efforts to chart their own futures. I underscore how Maasai pastoralists are central innovating agents in a shifting socioeconomic landscape who repurpose solar technologies as tools of negotiation between "modern" development initiatives and their own desires to remain anchored to elastic ancestral traditions that are often-characterized by their special relationship with livestock. I then discuss other instances of Tanzanian innovation—battery charging, electronics repair, and solar entrepreneurship—to suggest that experimentation (with risk) constitutes a productive direction for technological collaborations between Tanzanians and others committed to innovation *from* Tanzania.

Dedication

Dedicated to friends and family of Arusha, Tanzania. Tuko pamoja.

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Chapter 1: Introduction

> *"The red that the Maasai wear symbolizes the strength of the community ties. It is the color of the blood of our cows with whom we have a special relationship. As children, we learn to take care of them…to look for signs of disease, where to graze, and how to avoid the poisonous bushes. Or what to do if the lions or hyenas attack…Sometimes the rivers flood, making it impossible to return home. Sometimes it gets late and the night comes…As the children of the Maasai, we are taught early on how to overcome fear and bring ourselves and cows home safely" (Mittal, 2018, p. 10).*

Lemta is a Maasai pastoralist. In March of 2018 I met him druing a market day in Komolo, Tanzania: a largely-Maasai town located sixty kilometers south of Arusha.[1] Lemta had slaughtered one of his many cows and was waiting patiently for his last few slabs of meat to be purchased before counting the day's profit. Lemta is popular in town and hopes to one day represent his community as village head. Today, however, he is a successful herder and livestock trader and assists his good friend, the current village head, in resolving both intra- and inter-town disputes.

Informed by decades spent herding cattle, goats, and sheep, Lemta is an expert in pastoralism's fine sciences. Each morning he feeds his cattle a special mixture of salt, soil and small rocks which help encourage digestion and a healthy appetite. With sight alone he can determine if one of his animals is well-hydrated and if it has eaten enough for the day. He coordinates livestock reproduction with the seasons and, like most Maasai herders, steers his

[1] In Arusha Region's rural areas, whose inhabitants are largely Maasai pastoralists, each town has its own day where sellers of goods congregate in its city center to offer their products to the local public. Products can range from cups and chairs to locally-grown produce and entire flocks of goats. The sellers deploy their inherent human mobilities in conjunction with mobilities offered by forms of public transportation to provide even-distant communities with desirable products.

flock through the forest with a language of whistling, tongue clicking, and grunts. He knows the various health effects of forest plants and chuckles at inexperienced herders who allow their animals to graze without a careful watch over their diet's composition. The animals take on new personalities in his presence as he confidently points out which kids are the descendants of which goats and teases them for their silly behaviors. These details matter on market day and they are the details through which Lemta accumulated wealth as a young man: buying calves and raising them to a healthy and profitable size. Today, he uses his attention to detail to tend to a large herd, send his children to school, and pay for his family's necessities.[2]

During the four days that I spent with Lemta, I went to pasture with Samson, the village head's son. Lemta and the village head have combined their herds and keep track of their animals with good memory and branded symbols. After a glass of hot tea, Samson and I set out in the morning with approximately twenty cows under our watch. Although I do not speak his primary language, Maa, Samson and I built a relationship upon funny eyebrow movements and a cluster of mutually-understood words: cow (*ngombe, enketeng*), dog (*mbwa, nguji*), sun (*jua, engelong*), and elephant (*tembo, orkanjuwai*). A few hours passed before a heavy rain rolled in. We took shelter under a tree. When the rains slowed, we emerged from beneath the low-lying canopy to the frightful realization that our cows were nowhere to be found. I was frantic. Samson, on the other hand, was calm, and quickly spotted a piece of fresh manure to which he attributed a member of our herd. We started to follow the droppings which ran near a well-traveled road at the base of a large hill. Despite my trust in Samson, my eyes scoured the hillside. There! I saw a cow, high on the hill, and brought it to Samson's attention. By any indication, it was a member of our herd. We diverged from the trail of cow droppings in favor of a long, uphill

[2] Interview, Lemta, 04/15/2018.

trudge through dense brush, towards a piece of evidence I considered undeniable. Twenty minutes later, we were close enough for Samson to determine that the cows on the hillside were not ours. We returned to the cow droppings and found our herd only a short walk from where I had questioned our initial heading.

The sun broke westward and I followed Samson's lead in directing the herd home with musical whistles and the occasional slap with my *engudi* (herding stick). Upon our arrival, my feet were sore and my legs exhausted. I sat down and told the story of our excursion to Lemta and his wife, who had prepared another hot cup of tea. Samson's strength was in full supply. He ran around the yard and kicked his soccer ball in-between chores. We were both content.

As Samson's foolish assistant, I experienced herding as more than an effort in mere subsistence. I reflected upon our day in the pasture. I had felt pride and confidence in the responsibility afforded to me as Lemta's wife milked the cows and saw us to our duties. I faced the elements as we navigated through the forest; around natural obstacles and the farms of nearby farmers; and outlasted the daily rain. I was overcome by worry for the safety of our cows and for my relationship with Lemta upon losing his livestock, only to be humbled by the confident precision of young Samson's knowledge. And as our herd grazed, I felt care for the animals and lost myself in a pleasant state of mobile meditation. Work, education, familial responsibility, and independence came together in my embrace of a long-practiced livelihood enduring in the 21st century.

In the presence of potent power dynamics where the words "American" and "Maasai" come saturated with deeply-rooted misconceptions, Lemta and I built an uncommon friendship. Much of our time together was spent attending to spontaneous questions and describing the realities of our respective homes. I shared that I had a passion for filmmaking and learned that as

a younger man, Lemta and his friends made a comical video about the elders in their community. Lemta asked if I was planning to take a safari and I told him that I didn't have the money. To each, the other was virtually unknown; but our embrace of mutual vulnerability – to open ourselves, our stories, and our truths to one another - created space for a novel understanding to be built. For Lemta, like many Maasai people, I learned that pastoralism is less subsistence than an inextricable part of his identity.[3]

Today, pastoral identities are becoming harder and harder to nurture. Pressures placed on Tanzania's national government to develop their tourist economy and adopt Western-designed conservation strategies have resulted in violent evictions and strict grazing restrictions that have pushed thousands of Maasai people off of land held by their communities since the 15th century.[4] Ngorongoro Conservation Area and Serengeti National Park - two of Tanzania's most-renowned nature preserves which draw thousands of tourists to the country each year - were once decorated with Maasai bomas. Yet over the last century, the Serengeti and Ngorongoro Crater have become commodities demarcated by material borders. As the animals and vast landscapes assumed foreign values limited to the aesthetic and financial, so too did the Maasai.[5] Their traditional dress and dance are glorified by tourists who pay extra to take pictures of one of the world's most famous tourist icons, a group which is believed to have stayed in the past (Mittal, 2018).

[3] Ibid.
[4] The history briefly described here is contentious and complicated. Many Maasai people today have had to come to terms with a dark past in which their ancestors took up arms against other pastoralist communities in the belief that cattle were their exclusive right.
[5] For more on how the meanings and values assigned to animals and natural resources in Africa changed as a result of the ascendence and endurance of colonial institutions see Clapperton Chakanetsa Mavhunga, *Transient Workspaces,* (Cambridge & London, The MIT Press, 2014b), 6-7.

In *Transient Workspaces*, Clapperton Mavhunga (2014b.) frames the national park and game reserve system, the hallmark of Western conservation science, as a colonial relic that "alienates biodiversity conservation from the very people who live with and might act as its first line of defense from unscrupulous outsiders and corrupt politicians." He continues, writing that today, "development [is] *for* [Africans], but not *with* them" (Mavhunga, 2014b., p. 7). Such, then, is the direction of this thesis: to contribute to a larger discussion on the positionality of ordinary people in science, technology, and innovation that has undergone considerable transformation under the auspices of a group of innovative Africanist thinkers led by MIT's Clapperton Mavhunga.

In his edited collection of essays titled *What do Science, Technology, and Innovation Mean From Africa?*, Mavhunga (2017) draws attention to STS scholars who have made a habit out of deploying Western-derived concepts to order African empirical evidence. Their priority, Mavhunga states, is to follow Western-derived phenomena and science, technology, and innovation as defined in Western societies – a partiality that has had the effect of reducing African people to mere recipients of inbound, Western-made innovation, while technological objects are lauded as central innovating agents, the "doers," and the solutions to local problems. Although helpful for understanding specific versions of technology and how inbound forces operate, these analyses leave little room for considering African versions of technology and the meanings and practices with which they are associated. By attending to such frameworks, we restrict ourselves and our readers from considering what technology means from people of the Global South and the potentialities inherent in their engagement with intellection, philosophy, and the world as a source of things rendered technological (Mavhunga 2017a.).

We owe it to industrialists of 19th century America and natural scientists of Europe's scientific revolution that "technology" was reduced to machines and "science" to secular experiments in built laboratories. The legacy of these historically-specific and politically-sited classifications is a geophysical zoning of the definition and directionality of technology; technology is for academy-trained engineers and can only come from the West and is "transferred" to technology-poor Africans. In such discourses, African people are "pre-industrial," aspire to the rank of mere "informants," and exist inconsequentially on a "stuck" continent without movement or development to exhibit (Mavhunga, 2017a.). "Perhaps in the future, there will be some African history to teach," said Hugh Trevor-Roper, Professor of Modern History at University of Oxford, "but, at present there is none: there is only the history of the Europeans in Africa. The rest is darkness" (Mavhunga, 2017a., p. 6).

Figure 1. Sourced from American-led solar energy company (About Us, n.d.)

It is hard to imagine a device fueled-more by this legacy than solar energy. Liberal-minded solar energy entrepreneurs from Western countries are worshipped by mainstream media

outlets for "lighting-up Africa."[6] In these stories, solar energy is fully equipped to address the continent's dismal state of "energy poverty." In a 2017 report by The New Yorker, writer Bob McKibben hails American-led solar energy start-ups for bringing lifestyle improvements with solar powered lightbulbs, radios, television sets, and speakers (p. 48). He celebrates liberal "Ivy Leaguers" – described as high-tech, dope-growing progressives - for their capitalist contributions toward "electrifying Africa…one of the greatest development challenges on earth" (McKibben, 2017, p. 46).

Driven by the progressive West's concern for climate change, solar energy is placed on the global elites' symbolic pedestal for responsible modernization as a clean energy catalyst for meaningful, decentralized development. When they are included, African people come into these stories as grateful recipients, stubborn politicians, assistants, and "tinkerers"; in other words, as people incapable of making any meaningful contribution to solar energy's future on the continent.[7] But are these the only stories to be told?

In February of 2018, I met the the founder of an electronic waste (e-waste) recycling company headquartered in Tanzania. Our conversations revealed the precarity of one of the solar energy industry's core pillars: sustainability. Average lifetimes for lead acid batteries used with many Tanzanian home solar systems hover around two years. When these batteries "die," their contents are dumped on the way to crudely-run warehouses where laborers break open empty

[6] For one such example see "Light Up and Power Africa – A New Deal on Energy for Africa," African Development Bank Group, https://www.afdb.org/en/the-high-5/light-up-and-power-africa-%E2%80%93-a-new-deal-on-energy-for-africa/ (accessed January 10, 2019).
[7] For more about why such titles, "tinkerer" in particular, are violent in their reduction of African people to clumsy, unskilled workers who meddle in trial and error processes see Mavhunga, "Introduction: What do Science," 7.

batteries with machetes. Other components of these home solar systems – such as charge controllers and remote activation/de-activation systems - are made out of a variety of materials extremely difficult to recycle. A meticulous separation process is necessary before transporting these materials to "responsible" recycling facilities off the continent.[8] Hearing the details of solar e-waste was my first exposure to what I call the *dark side* of solar: in this case, an international web of exchanges intimately tied to the fundamental environmental problems of our global economy (for an excerpt from my conversation with the founder of the e-waste recycling company, see Appendix A).

Masked by progressive ideologies, solar is comprised of plastic and metallic materials dug from the earth and processed to produce profit controlled by large corporations through which a final solar product is finally distributed - bearing suggestive slogans such as *ubora wa kijerumani* (German quality) and *solar bora, maisha bora* (better solar, better life).[9] As an inboud device, solar energy "[comes] from sites of production marked by exclusions on the basis of race and gender… [and is] produced by white males…[in order] to make wealth, power, and prestige for them in Africa" (Mavhunga, 2017a., p. 7). Mavhunga (2017a.) writes that "it is not enough, however, to have an account of how these white technologies, this white science, unfolds in the hands of white agents at the expense of black victims" (p. 7). Confronting a solar energy reality characterized by colonial practices and veiled behind a dangerously simplified public image, I began to conceive of this thesis as a search for stories that could answer the question, who or what might light-up solar?

[8] Interview, founder of e-waste recycling company, 3/30/2018.
[9] Field notes recorded while working for a foreign solar energy company. These slogans are printed on the surfaces of the packages that carry their solar energy products.

Swahili language fluency connected me with the people who would help me try to answer this question.[10] For ten months beginning in August of 2017, I lived in Usa River: an Arusha Region town that sits directly between Arusha's city center and Kilimanjaro International Airport. People called me *tembo* (elephant) and at various points throughout an ordinary week I could be seen relaxing with friends at a local car wash, at Kwa Shebe drinking sodas, and helping my host mother at her stationary shop while other foreigners flashed by in elegant off-road vehicles heading towards Tanzania's famed wildlife preserves. Knowledge of Swahili allowed me to build friendships and participate in dialogue that I believe would have been impossible otherwise.

Granted access to people and their stories, I too granted access to myself and my stories – at times, a literal exchange of questions and answers mediated by individual interests. Partly informed by my coursework as an electrical engineering student, I probed for dialogue regarding electrification, energy, and solar energy technologies. In a time when development discourse often centers around Western ideologies, I came to value these forums as a way for Tanzanian perspectives of science, technology and innovation to reach an international audience.

After five months, I began a period of multi-sited ethnographic fieldwork that ended in May of 2018. Unstructured and semi-unstructured interviews with friends and acquaintences were my core methodology. I guided these interviews with a commitment to *sociotechnical imaginaries*: a theoretical concept concerned with science and technology's implications in the imagining of good and attainable futures (Jasanoff & Kim 2015). Engulfed by stereotypes of Maasai people that swirl widely throughout Tanzania's social and political spheres, I felt a sort

[10] I would like to thank all of my wonderful Kiswahili professors for enabling me with the skills to conduct and transcribe interviews in Kiswahili.

of urgency to hear *their* stories - to make an effort, at least, to represent Maasai people in a light partial to their ingenuity and expertise while also considering perspectives from other demographics - namely, city dwellers of Arusha and representatives of privately-owned, foreign solar energy companies. In essence, I wanted to understand if, how, and why different groups of people imagine their futures differently alongside solar energy technologies. I was hopeful that by attending to individual people's imaginaries of solar energy, I would gain insight into technologies, innovations, beliefs, and value systems coming from the interviewees themselves that create, erase, and/or modify solar possibilities. I supplemented interviews with participant ethnography as a participant in a renewable energy development summit and as a home solar system installer for one of the country's largest foreign solar energy companies. When included, the names of people and interviewees have been changed to pseudonymns.

Clapperton Mavhunga (2017a.) writes that "things do not (always) have the same meaning everywhere; when we insist that only 'our' meaning is the 'true' meaning, we silence other people's meanings" (p. 1). Over the course of conducting these interviews, I found solar energy technologies reappearing within Maasai communities as tools appropriated and configured to strengthen pastoralist life – to work alongside ancestral traditions and promote pastoralist development amidst a changing socioeconomic landscape. As opposed to developers situated outside of Maasai communities, for whom electrification often serves to incorporate Maasai people into legible, "proper" economies controlled by dominant institutions, Maasai people deploy solar energy technologies in their resistance to oppressive state-making projects –

such as Western-designed conservation and, as will be discussed later, grid electrification.[11] Maasai people, through their adaptability and creativity, are the central innovating agents of solar energy. In other words, solar energy in Northern Tanzania can be understood as a Maasai pastoralist technology.

Organization

My favorite Swahili proverb reads, *akili ni nywele; kila mtu ana zake*. In English: intellect is hair; each person has their own. Through this essay, I hope to show my reader that there are powerfully diverse intellects at play in Northern Tanzania – a region with colonial legacies abound. Of the most enduring of these legacies is the national park and game reserve system: the backbone of Tanzania's tourist economy which uses a skewed logic of development to justify violent evictions of Maasai people from ancestral land. I want to argue that for more than their rich medicinal, philosophical, and cultural traditions that stem largely from their values as pastoralists, ordinary Maasai people are creative beings – designers and innovators in their own right – who are able and ready to contribute to the development of the 21st century's globalized world.

Mavhunga (2017a.) writes, "the task of doing STS in nonwestern contexts…[requires] taking seriously what technology means from the perspective of people of the [Global] South. It requires not merely looking at how people respond to incoming things, but placing the latter's arrival, meanings, knowledges, and materialities within the locals' technological longue durée"

[11] The word "proper" used in this sentence is a reference to common political narratives propogated in post-independence Tanzania in which rural people were to settle in "proper villages" and rely upon "proper economies". For more about the political imagination of post-independence Tanzania see James Scott, *Seeing Like a State,* (New Haven & London, Yale University Press, 1998), 223-261.

(p. 4). In the sections which follow, I provide an overview of Maasai people's complicated relationship with solar energy technologies in order to interrogate popular conceptions about development, electrification, and modernity - made by private solar energy companies and the Tanzanian state - that have the effect of limiting the positive development impact of both solar energy devices and Maasai pastoralism. Considered within the longue durée of Maasai technological and cultural history, solar energy devices take on new forms, new uses, and new meanings guided by a mixture of endogenous and exogenous value systems. I hope this essay provides the reader with new ways to imagine both solar energy and Maasai pastoralism in Tanzanian futures.

Additionally, I want to acknowledge that embracing the risk of vulnerability is central to any honest attempt at decolonizing energy in Northern Tanzania. Maasai people sacrifice elements of their culture and their livelihoods in order to place themselves at sites where better opportunities in a rapidly-changing socioeconomic landscape exist. Maasai people's experimentation with state-sponsored institutions resulted in their exposure to solar energy technologies sold in densely-populated city-centers where the ability to herd cattle was non-existent. I hope to convey that there is room for experimentation and an embrace of the risks of vulnerability from Tanzania's national government and international institutions too – to explore uncommon strategies for (energy) development that Juno Parreñas (2018) says would require letting go of the aspirations for a "safe inequality" (p. 41).

In Chapter 1, I draw heavily from James C. Scott's work *Seeing Like a State* (1998) as I synthesize key events in Tanzania's history of modernization. This section will show how Tanzania's expanding national electric grid was made possible through violent state-making projects enacted by Tanzania's early political leaders who were inspired by colonial logics. Next,

Chapter 2 will show how the Maasai became situated antithetically to state imaginaries for an industrial, "modern" future. In Chapter 3, I provide an overview of the sociotechnical imaginaries of solar energy that are held by the Tanzanian state and foreign solar energy companies. To problematize the latter, I focus on the Energy Safari, a national renewable energy summit that sought to catalyze productive uses of solar energy in two Maasai communities. In Chapter 4, I dive into a collection of Maasai innovations of solar energy that I encountered during fieldwork. Finally, I conclude, in Chapter 5, with an overview of a few inspirational acts of creativity and ingenuity from the non-Maasai people who I interviewed and built relationships with while living in Arusha.

I am not an expert on anything discussed in this essay. My analyses, arguments, and descriptions are entirely inadequate for the complex ideas and people I attempt to depict. Moreover, I am aware of the problematic ethicality of my very presence in Tanzania. My positionality as a white American male has had an undeniable impact on my research.[12] Admittedly, I often felt more comfortable interacting with fellow men with whom a perceived trust was quicker to galvanize. My access to female perspectives, then, was limited by both personal and cultural reasons. A silenced female voice, however, should not be read as an absence of innovation or solar energy potentiality coming from Tanzanian women. Rather, the fleeting moments of solar energy dialogue that I had with female interviewees suggested a compelling link between the female experience and solar energy in Tanzania. As the heads of their households, women are managers of energy resources and could be invaluable collaborators

[12] For more on positionality in academic scholarship and knowledge production see Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective," (*Feminist Studies, 14*(3), 1988), 575-599.

towards novel theorizations of energy that lay situated within female knowledges. The research that I have conducted here, however, does not explicate this link.

Despite this failing, I have tried my best and hope, at least, that the reader can use this thesis to inspire further engagement with science, technology, and innovation coming from Maasai communities and Tanzania. I believe that ordinary Tanzanians have an *extra*-ordinary ability to chart a radical solar energy future for their country. These are people who, today, light-up solar.

Chapter 1: History of Modernization in Tanzania

> *"If you ask me why the government wants us to live in villages, the answer is simple: unless we do we shall not be able to provide ourselves with the things we need to develop our land and to raise our standard of living. We shall not be able to use tractors; we shall not be able to provide schools for our children; we shall not be able to build hospitals, or have clean drinking water; it will be quite impossible to go on depending on the towns for all our requirements; and if we had a plentiful supply of electric power we should never be able to connect it up to each isolated homestead." – Julius Nyerere, inaugural address to Tanzania's parliament, 1962 (Scott 1998, p. 230).*

Harnessed by the great modernizing forces of East Africa, energy has meant order. Its extraction, distribution, and depletion have been facilitated through complex systems of warped materials and coercive force. Human muscle coordinated and directed. Electricity generated and consumed (Mavhunga 2014a.). The history of modernization in Tanzania is well documented by scholars and serves as a necessary starting point for this essay, for the larger context within which Tanzanian solar energy and innovation sit owes much to the large piles of (electric) rubble whose stories dominate the historical record (Scott 2019, 33). I pay specific attention to Tanzania's controversial Ujamaa Campaign: a political-economic objective sought by Julius Nyerere, Tanzania's first president, that attempted to permanently settle most of the country's rural population in villages planned and organized by the state.[13] Using work conducted by James C. Scott (1998 & 2009), I suggest that the events surrounding and reverberating from

[13] Educated in England, Julius Nyerere took to the presidency convinced, at first, of a communist form of government. For more information about the Julius Nyerere see John Iliffe, *A Modern History of Tanganyika,* (Cambridge, Cambridge University Press, 1979).

Nyerere's Ujamaa Campaign created the preconditions for the various, sometimes-competing, imaginaries of Tanzanian electrification which exist today.

Scott's account of compulsory villagization begins under British colonial rule in East Africa. Resettlement was an integral part of many agricultural development schemes that mobilized African labor for British profit. Forced subscription to colonial crops was coupled with strict regimens of soil conservation and livestock regulation in what Scott (1998) describes as "complete faith in what [colonial] officials took for 'scientific agriculture' and a total skepticism about the actual agricultural practices of [Tanzanians]" (p. 226). In an effort to repudiate the resistance of local farmers well aware of environmental constraints and convinced of the logic of their own farming practices, schemes were paired with rigidly designed agricultural sites – "the more the planners filled in the details, the greater the chance of controlling the scheme and keeping it to its designed form" (Scott, 1998, p. 226). In reality, colonial agricultural methods were developed with a model of agricultural production unsuited for the local and social environment: a model inspired by aesthetic and visual standards of ordered and productive agriculture in the West (Scott 1998).

Despite the model's incompatibility with environmental and strategic variabilities understood well by local cultivators – both farmers and pastoralists alike - Tanzania's early political leaders chose to subscribe to an agenda almost inseparable from the blueprint of the modern state itself: "to ensure that [peripheral peoples'] economic activity was legible, taxable, assessable, and confiscatable or, failing that, to replace it with forms of production that were" (Scott 2009, p. 5; Scott 1998, 235). Tanzanian villages were to be spread evenly across a rectangular grid of fields and linked by roads. They were to act as the centers of technical and social services provided by the central government (Scott 1998).

Scott (1998) argues that for Nyerere, village living, development services, sedentary agriculture, and mechanization were a single indissoluble imaginary of his newly-independent Tanzania (p. 231). Electric power and industrialization became facets of this imaginary as the country's first hydroelectric dam, *Nyumba ya Mungu*, opened in 1969. Where successfully-organized ujamaa settlements formed, industrialization and grid electrification began to constitute a new, state-held imaginary of a productive economy amidst the disrupted ecological balance between cultivators and the land.[14] The extension of the state's development vision from sedentary agriculture to electrified industry is best-depicted in the seminal document titled *The Tanzanian Development Vision 2025*. In this document, drafted under Tanzania's third president, Benjamin Mkapa, the state and foreign supporters delineate a vision for development poised to graduate Tanzania from a least developed country to a middle-income country by 2025. With apparently significant help from Japan and Ireland, *The Tanzanian Development Vision 2025* solidifies the state's aspiration for a strong economy defined by industrialization and sedentary agriculture, in addition to resilient transportation and energy infrastructures through which the former is enabled (Malocho 2000).

The logics of Western superiority, aesthetic order, and legible productivity that substantiated state hopes for an industrial economy also created a dialectic between the idealized Tanzanian citizen and the "stubborn barbarian" at the periphery. Pastoralists committed to semi-nomadic settlement patterns: Maasai people became a sort of antithesis for state aspirations. In Scott's analysis of Zomian mountain peoples in *The Art of Not Being Governed* (2009), the allure of life beyond boundaries of state influence necessitates a political "othering" of peripheral peoples (p. 6). In Tanzania, the othering of Maasai people is exhibited by Operation Dress-Up, a

[14] Interview, Historian of Tanzania, 8/5/2018.

Nyerere-era campaign that sought to induce the Maasai to wear "modern" attire (Schneider 2006). Their traditional dress of colorful cloth and vibrant jewelry seemed to represent symbols of dissent against a state imaginary for a Tanzanian populous unified by legible productivity.

Tanzania's fifth president, John Magufuli, has yet to break with this modernizing tradition. His political platform, *kufufua viwanda* (to revive the factories), has become a sort of rallying cry for Tanzanians hoping to reap the benefits of an industrial future. "With resilient infrastructures, factories will put our kids to work," his supporters say. A clear precipitate of *The Tanzanian Development Vision 2025*, Magufuli's government is transforming into a well-oiled machine. Electronic receipt modules have been deployed to ensure comprehensive taxation, an exodus of corrupt government officials is underway, and the national electric grid is spreading to settlements further and further away from established metropolitan areas. Some would dare to say that Tanzania is "catching up".

The language of development and backwardness are even endemic in Tanzania's everyday urban language. My relationships with young, city-dwelling Tanzanians facilitated my familiarity with the sometimes-funny, always-creative, *lugha ya mtaani* (street language). In Arusha (a.k.a *A-Town* or *Arachuga*) various forms of *lugha ya mtaani* can be found. As one might guess, there are a plethora of words used to describe the foreign tourists who flash by city centers in elegant, off-road vehicles on their way to the national parks and game reserves west of Arusha. My favorite of these words is *mlami*. The *m-* prefix denotes a human. *Lami* means pavement. Together, *mlami* means a person who lives in pavement; or a paved person. The name comes from rumors that Western and East Asian countries are entirely paved, without dirt roads or natural foliage to exhibit. The person who calls foreigners *walami* (*wa-* denotes multiple

humans) might use a similarly-creative salutation to ask about another's day. When asked, *vipi?* (how is it?) a person will respond, *kama mbele* (like I'm ahead). The word *mbele* used in this response is the same *mbele* used to describe the relative position of "developed" countries, like the United States, to Tanzania: ahead. The response, to my best understanding, is a lighthearted reframing of the common development narratives in which Tanzania is behind. Their day is good, so they, like Americans, are ahead.

Chapter 2: Situating the Maasai

Serengeti National Park is one of Tanzania's most celebrated tourist destinations. Translated from Maa, a language of the Nilotic ethno-linguistic group spoken by Maasai people, Serengeti means "the place where the land runs on forever" (Mittal 2018, p. 10). Oral tradition says the Maasai arrived here in the 15th century, after migrating from a region of the lower Nile valley on the border of South Sudan and Kenya. Beginning in the mid-20th century, conservation laws and the interests of foreign investment started to push Maasai people off large tracts of inherited land, including the land of the Serengeti (Mittal, 2018, p. 22). Demarcated by material borders, the land that once ran on forever assumed foreign values limited to the aesthetic and financial. So too did the Maasai. Their various cultural practices have become trademarks of one of the world's most famous tourist icons: a group which is believed to have stayed in the past. Today, Maasai enter the Serengeti as objects of fascination for foreign tourists or as delinquent pastoralists.

The formation of the national park and game reserve system can be understood as a particularly insidious component of Tanzania's strategy to modernize: a state-building tactic with colonial roots that aims to strip Maasai people of illegible pastoral autonomy and fully incorporate the Maasai into the state's political economy. Necessarily, the Maasai are denied the status of expert conservationists - shunted towards arid environments unsuited for grazing or into dense metropolitan areas where conflicts between farmers and pastoralists have arisen. Clapperton Mavhunga (2014b.) writes that "the game reserve in Africa is a colonial relic struggling to adjust to a postcolonial reality… Political and financial powers of politicians and international nongovernmental organizations alienate biodiversity conservation from the very

people who live with and might act as its first line of defense from unscrupulous outsiders" (p. 7).

In August of 2017, the Maasai land struggle reached a crescendo. 185 bomas were burned under government orders in Tanzania's Loliondo region "in order to preserve the ecosystems in the region and attract more tourists", said a government representative (Mittal, 2018, p. 9). Thousands of villagers were displaced, food was destroyed, and livestock was lost. By early September, the extent of the damage had grown, with reports that 19 people had been arrested, 11 seriously injured, over 5,800 homes damaged, more than 20,000 left homeless, and significant losses of livestock (Mittal 2018, p. 9). These events were recounted to me with frustration, mere weeks after their occurrence, by a Maasai land rights activist.[15] Despite repeated requests to pursue cooperative solutions with the Tanzanian state and private corporations – that have included shared land agreements and modest demands to continue deploying finely-tuned subsistence strategies on ancestral land immune to fear of violent persecution - Maasai people are understood as roadblocks to the state's economic agenda hidden beneath the guise of Western-designed conservation (Mittal 2018, p. 14).

Maasai people's ontological positioning within the logic of development encouraged by international institutions and adopted by the Tanzanian state, of which the national park is a part, has subjected the Maasai to relentless pressures to adopt technologies of modernization.[16] These technologies represent sites of contestation, disagreement, and, sometimes, adaptive negotiation for Maasai people trying to make the most of their lives amidst a changing socio-economic

[15] This activist will remain nameless for the dangers associated with becoming exposed to the government.

[16] For more about the role of ontology in describing how science and technology can serve as tools of racist domination see Clapperton Chakanetsa Mavhunga, *Transient Workspaces,* (Cambridge, MIT Press, 2014), 5.

landscape. Maasai people, state officials, private companies, and international institutions wrestle for the power to implement technological strategies that will meet their own ends.

Fat, sedentary cattle are one such technology: a state-sponsored solution for pastoralist people whose lives seem incompatible with agriculture and grid-electrified production. Like the grid, fat cattle are immobile and require large and constant supplies of food and water each day. Attuned to the environmental variabilities of Northern Tanzania, Maasai cattle are, by contrast, mobile. Their hooves have large surface areas and their bodies are light, characteristics which preserve the soil and greenery upon which they walk. Maasai cattle are resilient to the elements, able to survive for multiple days without food or water. In an uncertain climate that seems increasingly defined by drought, the suggestion to herd fat, immobile cattle is misguided. The skinny cattle preferred by Maasai people can be understood as a specific type of energy technology deployed to convert natural foliage intto caloric energy and conserve communally-shared pasture - the latter of which is a philosophy upon which generations of pastoral expertise has been built. Expert herders know these cattle well. As seen in the expertise of Lemta described in the introduction, a seasoned herder will know by sight if a Maasai cow is well-hydrated, well-fed, or sick. The pressure to herd fat cattle sheds light on the types of multi-faceted tactics used against the Maasai to contain their mobility and their knowledge and render them subject to an organized, legible, immobile economy supported by state-sponsored technologies.

Having seen solar panels adorning Maasai homes at the periphery of Arusha's metropolitan area, I was interested in how the Maasai activist referenced above viewed solar energy. Since solar energy devices are a technology lauded in support of the imaginary of sustainable, environmentally-friendly development that is often-championed by international

development institutions, I expected to hear that it, too, violates the pure form of semi-nomadic pastoralism revered throughout the activist's presentation. To my initial surprise, the Maasai land-rights activist, who spoke bitterly of prejudices against pastoral life, declared the opposite. Maasai people love their cell phones, they said, and solar energy can be an appropriate way to supply their charge.

In the confrontation between long-practiced pastoralist traditions and state-sanctioned laws and policies designed to criminalize those practices, Maasai people are deploying certain types of solar energy technologies in creative ways to meet their own ends. The combination of endogenous and exogenous ideas and materials creates new possibilities for ideal pastoralist lives to be lived amidst a changing socio-economic landscape.

There is hope in the blurred lines between the preservation of ancestral tradition and cultural transformation. Following Juno Parreñas's work *Decolonizing Extinction* (2018), I want to argue that an embrace of the risk of vulnerability, which has been initiated by many Maasai people, deserves its complementary from foreign companies and state-run institutions. Solar energy is the object through which I intend to argue this point – for conditions leading to and resulting from some Maasai peoples' adoption of solar energy devices illuminate this embrace. The lack of culturally-appropriate opportunities emanating from state imaginaries of the electric grid - in its rigidity – and private sector imaginaries of proper solar energy - in its willfully-ignorant cosmopolitanism – empowers Maasai people to carve out their own spaces for experimenting with endogenous and exogenous ideas and materials "while one's feet remain planted in the elastic traditions of one's ancestors" (Mavhunga, 2014b., p. 8). In other words, Maasai people know what technologies they want to use and aren't afraid to adapt to use them

(Masolo 2017, 35).[17] Solar energy has become part and parcel of this elasticity. Skinny cattle, too, have remained.

[17] For more about how Maasai people are key intellectual agents who selectively deploy technologies oriented to support their development agendas see D.A. Masolo, "The Place of Science and Technology in Our Lives: Making Sense of Possibilities," In *What do Science, Technology, and Innovation Mean from Africa?,* ed. C. Mavhunga, (Cambridge & London, The MIT Press, 2017) 29-44.

Chapter 3: Sociotechnical Imaginaries of Solar Energy

"Innovation is spawned by the needs and imaginations of the world" – D.A. Masolo (2017, p. 36).

Science and technology are inextricable from the social worlds in which they exist. Material and intellectual forms, both present and future, are co-produced alongside social forms and social lives vis a vis human agents and their collectives.[18] It is in this way that solar energy devices can be configured to oppose and support the ideals of disparate, even conflicting groups simultaneously. In this section, I show how specific sociotechnical imaginaries held by the Tanzanian state, and specific sociotechnical imaginaries that undergirded a renewable energy summit organized by two international development organization, are affecting the materials and ideologies that support specific types of electric infrastructures.

State Imaginaries of Development

Near the turn of the 21st century, the electric grid was becoming a common service provided to villages and towns within close proximity to large economic centers such as Arusha. It was gaining popularity and ubiquity with the people as a result of their collective effort.[19]

Serikali ilileta huduma ya umeme kwa watu. Kwa hiyo ilikuwa ikiandikisha watu na kuwapa elimu kwamba unahitaji kuwa na umeme. Sasa kijiji ni kikubwa. Na	***The government brought electric service to people. So, it was registering people and giving them education about their need for electricity. Now our***

[18] For more about the "co-production" of knowledge in society, see Sheila Jasanoff, *States of knowledge: the co-production of science and the social order,* Routledge, 2004).
[19] Collectively-organized development projects have shown up elsewhere in my fieldwork. One interviewee told me about a water project organized by her community in which even young kids participated in the clearing of space so that pipes of water could pass.

kipindi hicho, kwa kweli umeme ulikuwa ni kitu kigeni katika jamii nyingi. Kwa hiyo sasa serikali ilitoa fursa ya watu kujiandikisha na kuchanga pesa ili kununua nguzo, kwa sababu nguzo zilikuwa ni gharama sana. Kwa hiyo kijiji kilijipanga na kikanunua nguzo ambazo zitapita katika barabara kuu ambazo zitarahisisha kutoa umeme mjini kuleta hicho kijiji. Halafu mtu mmoja mmoja ataweza kuvuta umeme kupitia hizo nguzo. Kwa hiyo umeme mkubwa utaletwa baada ya wanakijiji kuchanga pesa ya kuleta nguzo. Kwa hiyo serikali itatoa nyaya na mafundi bure. Kwa hiyo umeme mkubwa uliletwa na watu mmoja mmoja wakaanza kuvuta umeme kupitia hizo nguzo.

village was big. And during that time, truthfully, electricity was a foreign thing in many communities. So, the government offered the opportunity for people to register themselves and contribute money to buy electrical poles, because poles were very expensive. So, the village planned and bought poles that passed via the main road and made it easier to take electricity from the city and bring it to the village. Then, one by one people would be able to pull electricity from the poles. So, the large electricity will be brought after the villagers to contribute money and bring poles. So, the government will offer wires and technicians for free. So, the big electricity was brought and one by one, people started to pull electricity from those poles.[20]

Today, funds used to buy the electrical poles needed for the expansion of the national grid no longer predicate upon the cooperative efforts of the country's citizenry. The Rural Energy Agency (REA) is an autonomous body established under Tanzania's Ministry of Energy and Minerals that has been given the role of improving and facilitating access to "modern energy services" in mainland Tanzania (Ministry of Energy and Minerals, "Who We Are"). Partnerships forged between REA and the private sector bring funding into the expansion of the national electric grid through eligible towns and settlements. In practice, REA is promoting grid expansion to and through communities organized in the wake of, and, in some cases, directly by Nyerere's Ujamaa Campaign.

[20] Interview, former resident of Dar es Salaam, 2/05/2018.

I want to argue that the importance in elucidating the relationship between REA electrification and the Ujamaa Campaign, explicated to me by citizens of Arusha, is to show that compulsory villagization, and its associated logics of development, have endured. Whereas Nyerere sought communist domination through the consolidation of people, Magufuli and REA partners seek capitalist domination through the interconnection of electrified modes of production and consumption. In this way, Nyerere's Ujamaa Campaign can be understood to have assumed a new (capitalist) form. REA pours its resources into towns where legible economic production is certain: capitalist "villages." Citizens living within these areas reap the greatest benefit: the short distances between their homes and businesses and the REA-established electric grid necessitates only a small service line connection fee before electricity consumption and monthly bill payments can begin. The cyclical nature of the electric force, rather than an inextricable human right, seems to exist in the eyes of the state to encourage competitive, capitalist ways of life that are taxable, confiscatable, and dependent on the very electricity through which they are enabled.

By refusing to distinguish between Nyerere's Ujamaa Campaign and REA, we can fully conceptualize the Maasai's and other peripheral peoples' ontological positioning vis-a-vis state-sponsored electrification. They are the political "other" to the state's imaginary of an electrified and industrialized citizenry: obediently-producing dependents. REA, then, can be understood as a government offensive that transforms the socio-economic landscape to its desired form. For poor and peripheral peoples like the Maasai - who watch their communities receive grid electricity along class lines and/or at the expense of cherished values while the national government opts to power state infrastructures with solar energy - the electric grid exists but

precariously in sociotechnical imaginaries of an ideal life (for an excerpt from a conversation in which the interviewee gives an overview of the government's solar projects, see Appendix B).

Kwa hiyo, sanasana unapojua kwamba umeme ukishafika mahali sanasana kwenye kijiji ina maana uongeza wa watu, watu wanakuwa wengi, tofautitofauti wa makabila zingine. Kwa sababu wengine watakuja watataka kufungua mabiashara na umeme ukishaingia mahali lazima itakuwepo na simu. Kwa hiyo itakuwa kuna mchanganyiko wa watu. Kwa hiyo, hiyo kweli Mmaasai anataka nyumba yake iwe na mwanga lakini, at the same time, they don't feel safe. Kwa sababu wako na ile population ya wale watu… na kutokana na wale watu ambao wamekuja, wanaishi pale, magari yanakuwa mengi. Unakuta sasa watoto tena hawana freedom ya kuvuka hata barabara. Au ngombe tena wanakuja na wanakuwa napewa limitation of grazing… Kwa hiyo inakuwa sasa yaani, haiwapi ile uhuru wa kuweza kuishi."

So, a lot of times, where you know electricity will arrive, a lot of times in villages, it means there is an addition of people. The population grows and comes to be comprised of various tribes. Because many people will come to open businesses and electricity - if it has already arrived - it is inevitable it will be here with phones. So, there will be a mixture of people. So yes, it's true, a Maasai person wants his home to have light but, at the same time, they don't feel safe. Because they are with that population of people…and from those people that have come, there will be many cars. You realize that now children don't have the freedom to even cross a street. Or cows come and they are given a grazing limitation… So, it is as if it doesn't give them the freedom to be able to live.[21]

Foreign Solar Energy Initiatives

> *"Ordinary people have no space for contributing ideas that might improve programs that are implemented in their name. People particularly resent being consulted at implementation, but never in the conception of projects" – Clapperton Mavhunga (2014b., p. 7)*

[21] Interview, Maasai pastoralist, 3/02/2018.

In late January of 2018, twenty-eight young Tanzanian citizens of diverse backgrounds gathered in Arusha, Tanzania for an "Energy Safari". Facilitated by two international development organizations – Hivos and International Institute for the Environment and Development - the Energy Safari aimed to create a supportive environment for youth to engage with the rising challenges in Tanzania's shifting energy landscape. "This sounds great," I thought, "but why an energy *safari*?" Informed by Mavhunga and Mittal, the "safari" can be understood as a colonial relic of the national-park game reserve system: a leisure activity designed for the exclusive enjoyment of foreign tourists and big game hunters whose profitability encourages violent evictions of Maasai people in the name of Western-designed conservation and economic development (Mittal, 2018, p. 17). Concerning, then, is the Energy Safari's decision to target two, largely-Maasai communities for its exercise. The details that follow have been synthesized from my 2018-report titled *Notes and Reflections from an 'Energy Safari'*.

The Energy Safari directed participants to think about "productive uses of energy" (PUE) in Komolo and Ketumbeine villages where privately-owned mini-grids act as the sole providers of grid electricity. The involved mini-grid companies generated problem cases which contextualized mini-lessons, discussions, and field excursions throughout the week. Reinforced by their dedication to decentralized, environmentally friendly solar energy systems, Energy Safari facilitators spoke highly of the potential inherent in solar-powered PUE. In clear and concise English, they outlined their highly aesthetic vision of rural solar energy. It would be decentralized from the national grid, but centralized around privately-owned mini-grids. The energy would be constant and reliable, unlike the electricity generated by Nyumba ya Mungu's evaporating power source. Finally, the energy would be used productively to catalyze and/or

streamline economic processes and empower rural citizens around income-generating activities - such as welding, carpentry, and horticulture - that depend on continual satisfaction of monthly bill payments.

The participants– twenty-eight Tanzanians and one Nigerian – nodded along. Although I was excited to see youth collaborating around energy issues, more than just the name of the program caused concern. First, facilitators of the Energy Safari chose to conduct the program in English, a choice that necessitated language testing for all applicants and confined Swahili to private conversations, field excursions, individual team discussions, and unofficial program activities. As a Swahili language student, I sympathized with my peers who I found hesitant to participate, un-engaged during long periods of information dissemination, and unable to fully express their ideas. The choice was justified as "good practice" and a necessary design for English-speaking facilitators and the Nigerian participant. I wondered how the *Energy Safari* would have differed had all participants been learning, discussing, and presenting in their native language.

Second, participants were constrained to think through problem cases designed by mini-grid companies and to produce solutions that ensured their success. More than a trace of the self-interested nature of the mini-grids' presence, partnerships forged between the Energy Safari and mini-grid companies held a powerful influence over how participants imagined "productivity" and appropriate energy futures and likely discouraged truly Tanzanian visions of energy development from emerging. After attending information sessions led by mini-grid developers, a participant began to question the use of biogas for cooking in his village, proposing that solar energy should replace biogas as a "better" form of energy. Especially for cooking, biogas is a

legitimate and sustainable energy resource. I don't live in his village, but I cannot think of a reason to swap biogas for bill-contingent electricity.

Finally, the Energy Safari missed an opportunity to build a radical understanding between historically marginalized pastoralist communities and young "change-makers" interested in energy. Instead, the Energy Safari merely continued a long-standing tradition of working around pastoralist communities instead of with them. Pastoralists were not included in the creation of problem cases and they were not represented amongst facilitators, "expert" panelists who judged solutions presented, nor the participants. Moreover, field excursions to Ketumbeine and Komolo were not mediated by local, Maa-speaking Tanzanians – a facet of the program which limited the pool of interviewees to the Swahili- (i.e. formally-) educated.

In addition to some participants, who cited "the nature" of pastoralist people as one of the biggest challenges for rural electrification projects, mini-grid developers also brought their stereotypes with them. One mini-grid representative mocked a well-founded decision by local pastoralists to keep "150 skinny cows instead of 50 fat cows" despite the physical stamina during migration, low water and food consumption, and resistance to diseases of these skinny cows. Meanwhile, these same energy developers look-on as pastoralist land is appropriated by private investors and the national government for more "productive" land use schemes, all in the name of "development" and "conservation." Such valuations of pastoralist land and efforts to develop pastoralist communities can be understood as extensions of a colonial logic – a logic that underpins the current national park-game reserve system and out of which the present-day "safari" was conceived.

The Energy Safari is illustrative of two important aspects of some foreign solar energy initiatives. First, they operate on certain a priori assumptions of "productivity" and

"development." Our team's fieldwork revealed popular support for mini-grid-fueled refrigeration for the preservation of meat not sold at weekly markets. Because our team was instructed to create a solution that improved the productive potential of horticulture, these suggestions never left our notebooks.

Second, foreign solar energy initiatives allow these aforementioned assumptions to constrain the technical design of solar energy solutions offered. Physically, the solar-powered "mini-grid" is true to its name. A shipping container-sized solar panel sits in the middle of town, under which batteries and DC/AC (direct current/alternating current) converters are stored: crucial components of the electrical system that distributes AC electricity to mini-grid-connected households and shops throughout town. The electricity travels via standard electrical cables placed on tops of electrical poles or in trenches beneath the ground. In Ketumbeine village, the mini-grid's electrical service is virtually indistinguishable from TANESCO's: electrical cables are strung atop electrical poles, distributing electricity to approximately sixty local customers. The only recognizable difference in service between TANESCO and the mini-grid is the monthly bill: corporate timelines for returns on investment have forced electricity from the mini-grid to run slightly more expensive. The result: those able to access the mini-grid are largely-unsatisfied with their service and patiently await the arrival of TANESCO to abandon their local solar power plant in favor of a less-expensive mixture of coal-fired, hydroelectric, and natural gas electricity.

Convenient it is, then, that mini-grids are designed with the electrical specifications of TANESCO electricity in mind. Written into their rights to supply solar-powered electricity is a stipulation that when TANESCO arrives to a mini-grid supplied area, the mini-grid will relinquish its control. Because the mini-grid companies will have utilized formal criteria, similar to those used by REA, to determine which villages and towns will receive their service -

circulation of money, population, productive capacity – TANESCO will move into a solar-powered town with the greatest of ease.[22]

At the hands of foreign program facilitators, the Energy Safari became a prime example of a skewed cosmopolitanism that erases local imaginaries. The argument here is not attendant to "ideal" nor "appropriate" sources of power. Rather, it is attendant to the practice of providing power and the role of power in determining the types of futures that are deemed possible. The Energy Safari chose to pursue solar energy solutions that embody the exclusionary nature, development philosophy, and even the technological design of the national electric grid. For Maasai pastoralists, imagined futures are still wrought with resistance.

Such remains true throughout Tanzania's foreign-based solar energy sector. Even companies that provide home solar systems isolate themselves and their services away from local influence. The ability to remotely disconnect a home solar system exists on the cutting edge of private sector solar energy innovation, putting a peculiar twist on the common narratives of "decentralization" regarding solar energy in Africa.[23] Enabled through partnerships with the region's largest telecommunications companies, remote disconnect happens when a household has reached the end of its grace period for late loan payments – usually three months. The solar system provider, from its far-away headquarters, activates and releases an electromagnetic signal which can propogate hundreds of kilometers to constrict power flow through a single node in its expansive network of home solar systems. Following remote disconnect, a company

[22] Interview, representative of privately-owned, foreign solar energy company, 2/03/2018.
[23] The narratives to which I am referring often compare solar electrification to mobile phones. African countries are said to be able to "jump" the electric grid just as they jumped traditional land line phones. For an example of an article that highlights solar energy as a decentralized energy resource see Gordon Feller, "The Decentralized Energy Future is Coming," T&D World, https://www.tdworld.com/distributed-energy-resources/decentralized-energy-future-coming (accessed 4/15/2019).

representative will promptly visit the delinquent home, repossess the solar system materials down to the last wire, and return to company headquarters to test and repackage the used system for subsequent customers. Despite the household's inability to continue loan payments, a circumstance that often signals the presence of a financial emergency, the money they have already paid according to the loan agreement is not returned. For the home solar system company, this is one of the most lucrative aspects of their business.

> *"It's the one place where we make money. I hate to say it. If we take a system back we refurbish it and we add components that need replacing, most likely a new battery. And we are able to put it out there, you know, eighty to ninety percent the original cost. And if someone has paid a million shillings [five-hundred U.S. dollars] you have actually made more money than you would have."*[24]

This is part of what I call the *dark side* of solar energy. What had, for me, existed wholly as an honest energy solution to global climate change seemed to fall apart in the very place where it promised the most hope. The sociotechnical imaginary of solar energy that receives liberal subscription in the West conflicts with a reality plagued by shady business practices and harsh contingencies. For many Maasai pastoralists, utilizing electricity provided by REA, privately-owned mini-grids, and home solar system companies necessitates a careful reevaluation of pastoralist life. The hope for prosperity in Tanzania's rapidly changing socioeconomic landscape has demanded from Maasai people a strategic repositioning of themselves and their traditions. Embedded within these processes of reevaluation and (re)positioning exists a continuous process of give and take where risks and vulnerability are

[24] Interview, representative of privately-owned, foreign solar energy company, 4/19/2019.

welcomed in exchange for the future success of pastoralist communities and their livestock. Here, uniquely-Maasai forms of solar energy arise.

Chapter 4: Maasai Imaginary and Praxis of Solar Energy

Figure 2. Engudi placed inside Lemta's home.

According to a version of the Maasai creation story, the universe began with three brothers. To the first brother, God gave a hoe, which the brother used to till the hills of Mount Meru. This brother represents the Waarusha sect of the Maasai lineage. To the second brother, God gave a bow and sheathe of arrows, which the brother used to hunt the plains. This brother represents the Wandatooga sect of the Maasai lineage. To the third and final brother, God gave an *engudi* (herding stick), which the brother used to guide his herd of livestock to pasture. This brother represents the Wamaasai sect of the Maasai lineage.[25]

Maasai people still carry these sticks today. They are long with slight flexibility, fashioned from a special type of tree. During my stay with Lemta in Komolo - one of the two towns that had watched Energy Safari participants come and go just a few months prior - I was given an extra *engudi* that was lying around the house. In Maasai culture, the gifting of an *engudi* is to be remembered by honoring the relationship between the two people involved. The gifter

[25] The notion of "Maasai", as is evident in this story, is not clear and unobstructed. The label "Maasai" that is used in this thesis is reflective of how most people in contemporary Tanzania society use the term: as a descriptor for the pastoralist Wamaasai. Interview, Maasai pastoralist, 1/22/2018.

will forever be called *engudima* (stick giver) by the giftee. Mine is beautiful and made me feel one with the other men in the community. Like them, I carried my *engudi* everywhere.

There is a special way to hold it when riding on the back of a motorcycle. You grab the very bottom and hold the engudi tightly so that it stands tall and firm as the driver speeds through town or through the forrest. Four-wheeled automobiles, however, present a different challenge. Especially in the often-crowded public transportation vehicles called *daladala*, a long engudi becomes a burden and can cause discomfort for the wielder and surrounding passengers. As such, Maasai men whose schedules/occupations necessitate frequent car transits carry a shortened *engudi*. With the appearance of a small club, the shortened *engudi* is an adaptation, or configuration, of the longer *engudi* bestowed to Maasai people by *Enkai* (God), made to accommodate the constraints of a fast-paced world by people who hold on tightly to their identity as herders. The engudi is emblematic of the link between Maasai people and their pastoralist traditions - a link that simultaneously ties the Maasai to the pasture, their livestock, and *Enkai*. With the fashioning of a shortened engudi primed for in-car transit, Maasai people show that their ancestral traditions are ready to adapt in order to secure a place within a changing socioeconomic landscape. Maasai people, too, are ready to adapt.

I met Zai, a Maasai man of about my age, in Arusha's city center. He had recently moved to the city to seek out new income-generating activities to support his family. His friend, Paulu, had considerable experience in the tourist industry and was helping Zai to accommodate to the fast-paced life in Arusha. Coincidentally, I happened to be visiting a friend near Zai's home when Zai made his first return. The goofy, light-hearted guy I had met in Arusha was received like a king upon his arrival. I was with him when he reunited with his grandmother. She cried

tears of joy when she saw him. It had been a long time, she said, and she was happy he returned home safely.

In years past, Maasai grandmothers like Zai's prayed in the mornings by tossing fresh milk three times in the direction of the rising sun. Milk's ritual and spiritual importance is manifest in many Maasai ceremonies and stages of personhood but often loses its sanctity in the presence of outsiders who see milk as a potential commodity and source of income generating projects.[26] Today, like the life of Zai and others who straddle geographic boundaries between the city and the pasture, perceptions of milk in Maasai culture are changing. However widespread traditions are, confrontation with "the new" alters the dynamic social, cultural, and political landscapes in which societies exist. Such a state of confrontation and adaptive elasticity is the context within which the history of solar in Maasai communities begins.

"They had dreams of their own and took bold risks to realize them...They located themselves at sites where better opportunities to acquire tools for realizing their futures existed" – Clapperton Mavhunga (2017a., p. 15).

In Maasai households where pastoralist knowledge is rich with ecological, philosophical, and medicinal practices, social pressure and the possibility for acquiring new opportunities have forced a reevaluation of the compatibility between the state's imaginary of a formally-educated citizenry and Maasai commitments to knowledge learned, refined, and practiced in the home and in the pasture. D.A. Masolo (2017) describes a similar confrontation in his own Kenyan community, writing that "the separation between the local and the 'new and important' became a visible process of mental and finally also social 'depaysement.' Home and school gradually

[26] Interview, Maasai pastoralist, 5/01/2018.

became two vastly different worlds: one ruled by important knowledge about a world that was distant physically, socially, and theoretically and the other by an array of knowledge regarded to be simple and domestic" (p. 29). Those expert pastoralists, however, know the value of their knowledge and have devised new techniques for integrating exogenous and endogenous educational values. In the history of Maasai solar energy, told to me by friends and community members living in Arusha Region, the very ability to (re)configure solar energy devices within the Maasai value system rested on their pursuit of formalized education and the risks of losing touch with pastoralist knowledge.

Faced with the possibility of new opportunities, Maasai families allowed their children to seek an education away from home. Parents held high expectations for young pastoralist explorers exposed to foreign environments. They should perform well in school but respect their knowledge and responsibilities regarding the herd above all. *Nyumbani ni nyumbani* (home is home) and before workers or students, they were pastoralists. Remember, it was the sacred cows whose monetary value enabled their education!

Katika kuchunga unatakiwa ukiwa nachunga lazima akili yote ipo kwenye machungani. Nilishaenda machungani na kitabu ili nisome baada ya kuanza shule, lakini baada ya wao kukuta mimi nikisoma huko ninachunga nilichapwa. Sana. Kwa sababu wao wanaamini kwamba wewe unaweza ukaangalia kitabu unasoma, ukasahau mbuzi, wakapotea ngombe wanapotea. Na hauwezi kuwa na akili mbili ya kusoma na kufanyaje.. Nikitoka shule siku ya kwanza kabisa wanasema 'machungan'i. Kwa sababu wewe unasoma na hata school fees tunakulipia kwa kutumia ngombe.

When herding you are expected to put your whole intellect into herding. I went herding with a book so that I could read after starting school. But when they saw me reading while herding I was punished. A lot. Because they believed that if you were to read a book, you would forget the goats and they would get lost. The cows would get lost. And you aren't able to have two intellects for reading and to do whatever else... When I come home from school the very first day [my parents] say 'to the pasture'. Because you study and we even use our cows to pay your school fees. So, if

Kwa hiyo ukienda nyumbani ni lazima na wewe uangalie hawa ngombe ambao wanakuwezesha wewe kusoma. Na hiyo ni kwa sababu ya sisi kuenda machungani. Kwamba ngombe wale, mbuzi wale ndio waliotusaidia sisi kuelimika.	***you go home it is required that you look after the cows that enable you to study. And this is our reason for going to pasture – that these cows, these goats, are the ones that helped us to become educated.***[27]

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As they had grown accustomed in the pasture and on long walks to retrieve firewood and water, Maasai students carried their families and their herds in their thoughts. They remembered how their parents charged their phone once per week when the regional market came close to home.[28] They may have also remembered the comfort felt by their cows in the presence of battery-powered torches:

.Kuna kipindi kuanzia miaka ya 2005, 2006, 2007. Sola zilikuwa hazipatikani sana. Lakini utakuta watu wengi sana, nishati ya umeme waliokuwa natumia sana ni torchi. Yaani utakuta kila mmoja, hasa vijana, kila mmoja anatamani kuwa na torchi kwa sababu walikuwa natembea usiku, kwa mifugo. Kwa mfano mimi kuna kipindi nilikuwa nashinda na mifugo kuanzia mchana mpaka asubuhi yake kesho niko porini	***There was a time period starting in 2005, 2006, 2007. Solar panels weren't very available. But you would find that many people, the electric energy that they were using were hand-held torches. You would fine each person, especially the teenagers, each person wants to have a torch because they were walking at night with livestock. For example, me. There was a time period I was with livestock starting around noon***

[27] Interview, Maasai pastoralist, 2/28/2018.

[28] On the outskirts of Arusha, sellers of goods follow a communally-organized schedule that determines to which town or settlement they will travel to offer their goods for purchase on a given day. On Wednesdays, for example, sellers of goods and local consumers congregate in Komolo. On Friday, the market will have moved to Terat, a town 15 km south of Komolo. On and on the market goes while Komolo residents have the utmost certainty that it will return on the following Wednesday. Since the market passes through well-established settlements that have received the national electric grid through REA, many Maasai people who were already travelling to the market brought their phones along too. They knew they would have an opportunity to source a charge.

na mifugo. Ama nimelala porini na mifugo. Ama natembea nao kuwasafirisha kwa maana walikoenda kupatia maji kurudi ni mbali mpaka wafike ni saa saba usiku ama saa nane. Kwa hiyo lazima niwe na torchi zile zitanisaidia kumulika pande zote za hawa ngombe nao ngome walikuwa napenda hilo mwangaza. Lakini pia wanyama porini wanapokuwa naona huo mwangaza wanakuwa naogopa kufisia ama kuvamia hawa mifugo.

and until early the next morning I was still in the bush with livestock. Or I slept in the bush with the livestock. Or I was walking to transport them because where they went to get water was very far, until they got home it would be 1 or 2 am. So it is a must that you have a torch, they help to illuminate all sides of the cows and the cows liked the light. But also the wild animals of the bush, when they saw the light they were afraid to invade the livestock.[29]

So, when Maasai students confronted solar energy and learned of its capabilities, they knew it had value back home.

Hizi sola tumekuja kuanza kuona juzijuzi tukiwa vyuo. Tumeanza kusoma vyuo, university, ndio tukaanza, tulipoanza kuingia mjini ndio tukaanza kuona sasa sola zinauzwa, tulianza, kwa ajili ya elimu tuliyoipata, tukaanza sasa kushauishi marafiki zetu, wadogo zetu, wanunue. Wapeleke kule.

These solar panels, we came to see them only recently while we were at university. We started to study at university, when we entered into the city we started to see solar panels being sold and we started, on account of the education we had received, we started to influence our friends, and younger siblings, to buy them. They should take them home.[30]

The narrative of solar energy in Maasai communities is contested space. It is where regimes of dependency and agency are constructed. The history of Maasai solar energy presented

[29] Interview, Maasai pastoralist, 2/13/2018.
[30] Ibid.

above might be understood as a refusal of fables propagated by the state and international institutions that obscure the Maasai and their fluid identities in favor of a conception of a people who need help, who are stuck. Although its material origins are external to Maasai communities, solar energy and its associated devices are manipulated by endogenous values deeply embedded in Maasai ways of life. By embracing the risk of vulnerability inherent in state-sponsored educational institutions, life in the city, and widespread societal pressures more generally, Maasai people confronted solar energy and configured it as a pastoralist technology primed to help their communities preserve and protect pastoralist values and knowledge systems misunderstood by the dominant powers of the day.

Inspired by James C. Scott's analysis of Zomian mountain peoples in *The Art of Not Being Governed* (2009), I liken Maasai appropriation of solar energy technologies to a sort of resistance. Scott suggests that pastoralism itself, rather than a historical remnant of an earlier stage of human history, was designed in response to "modern" institutions in order to ward off forced-incorporation into states and avoid the effects of their conquests: disease and forced labor in Amerindian societies of South America, for example (Scott 2009, p. 29). Scott says that time and time again, members of resistant societies, like pastoralists, adopt "escape" practices to thwart state appropriation by sedentary state societies (Scott 2019, p. 23). With this framework, Maasai people, with their configuration of solar energy devices to support life at the periphery, can be understood to be practicing a certain type of *escape electrification*.[31]

[31] While writing this thesis, I encountered stories of refugees from Myanmar who were fleeing persecution with the solar panels they had installed in their homes. For more about this form of escape electrification see Mushfique Wadud, "Fleeing Rohingya carrying one key asset: solar panels," *Reuters,* 2017.

Scott continues, pointing to the flux of people between Zomia's hill and valley societies to suggest a sort of symbiosis that necessitates reading the two forms of social organization (state centers and peripheries) together (2019). Given the information presented earlier in this section, a symbiotic description for the relationship between Maasai communities and Tanzania's metropolitan areas seems appropriate. Reading these groups and their priorities as tied, I think, necessitates a reframing of Scott's "resistivity." Rather than conflict, resistance - and escape electrification more specifically – exists in Maasai communities in cooperation with established city centers. What is resistive for Maasai people is not fugitive, as Scott might suggest, but cooperative: a proof of concept, if you will, for innovation spawned at the threshold of divergent lifestyles whose effects benefit the symbiosis.

I want to align the reading produced here with Parreñas's theory of decolinization (2018). She writes that "what makes an action a potential form of decolonization is its experimentation in how to relate to others beyond tired colonial tropes of violence and benevolence" (Parreñas, 2018, p. 7). Parreñas suggests that a theory for decolonizing extinction of non-human animals is to be found within the personal sacrifices made, and burdens embraced, by orangutang caregivers committed to the rehabilitation of semi-wild orangutangs in post-colonial Borneo. I suggest, in turn, that a theory for decolonizing energy and innovation in an era of mass fixation on climate change and technological progress is to be found in Maasai communities where the risks of vulnerability that come from living in an industrializing nation are configured to facilitate a convergence of different cultures, technologies, and forms of energy for shared advantage.

In the sections that follows, I give an overview of Maasai solar energy innovations that I encountered while living in Arusha. Contextualized within Maasai people's longue durée of

technological and cultural history, these innovations appear in conversation with values and knowledge systems endogenous to Maasai communities – namely, those revolving around the special relationship between Maasai people and their livestock. While not in any way comprehensive, and largely detached from the scientific and technological practices of Maasai pastoralism that has garnered some of its own attention in African STS scholarship (e.g. Masolo 2017), I hope that my engagement with solar energy as a Maasai pastoralist technology will provide a novel framework for (re)imagining pastoralist futures as modern, innovative, and technological in their own right.

Solar Mobility

Life alongside livestock can require agile migration by a household. For the Maasai, this capability has woven itself deep into the fabric of day to day life. The houses they construct, which are built out of locally-available materials like sticks, soil, and animal manure, are merely left where they stand upon migration.[32] Over time the houses and fences wither away, leaving only a trodden clearing to be observed. The inherent human mobility required by each Maasai person upon migration is developed over the course of a lifetime. For most of their lives, every day, from morning to evening, men and boys walk with their herd of cattle, goats and sheep. The women and girls follow an equally-demanding regimen of foot travel in the collection of firewood and water.[33]

[32] One responsibility of Maasai women is to construct the family's home.
[33] Done alongside the other women in the community, time spent gathering firewood and water is valued as a meaningful social space where female relationships are nurtured far from the presence of their husbands. I have heard stories where Maasai women oppose water development projects in their areas because they effectively remove this valuable social space.

When a rainy season fails to bring adequate rain for a household's livestock, a Maasai family may decide to migrate to a new home. Mobility guided by livestock is incompatible with the national electric grid. Solar energy systems, however, are portable – packed up and brought along as Maasai people continue to define appropriate patterns of mobility by the wellbeing of their livestock.

Kwa upande wetu wa wafugaji, ni watu ambao hawana makao sana. Leo uko hapa kesho uko kule kutokana na mifugo. Sasa, ina faida sana, maana ni umeme ambao unaweza ukaondoka nao. Pale utakapofika unaendelea kutumia…Kuna rafiki yangu mmoja, mimi nilipoanza kuchukua hii kampuni ya mobisol nilichukua sola mimi nilifuata kutoka hapa kuenda Terat. Nikachukua hiyo panel, akaja akaona kwangu. Akaniomba niwaunganishe na ile kampuni. Sasa nikaunganisha na yeye akaletewa akiwa nakaa boma moja hapo hivi. Na sasa hivi ameshahama ameenda boma linguine... akahamisha umeme wake. Hata hii ya kwangu nikitaka sasa hivi kuondoka nayo nahama. Maana ni kuchomoa tu sehemu, hamna wire yoyote ambayo imekatwa ambayo unasema inaombwa kifundi, hamna. Vitu vyetu ni kuchomeka tu tap tap tap unaendelea.

Us pastoralists, we are people who don't really have residence. Today you are here, tomorrow you are over there due to the livestock. Now, [solar] has a lot of benefits, because it is electricity that you can leave with. There, where you finally arrive, you continue using it…There is one friend, me when I started to get this Mobisol solar system I followed it to Terat. I got the panel and he came to my house. He requested that I connect him with the company. Now, I connected him and he was brought his system when he was staying at one boma over there. Now he has already migrated to another boma. …He migrated his electricity. Even mine, if I want to leave with it I'll migrate. Because it is just to unplug a part, there isn't any wire that must be cut that requires you to request a technician. No. Our things are just to unplug, tap tap tap and you continue on.[34]

[34] Interview, Lemta, 4/11/2018.

Jokingly, I've been told by non-Maasai friends to never believe a Maasai person who says a walk's destination is "just over there." They say that, in fact, the walk's destination could be miles and miles away. A short walk for a Maasai person, they suggest, is an exhausting journey for the rest of us. While staying with Lemta, Lemta's brother Daudi came to visit. He strolled into Lemta's homestead carrying a small solar panel, about the size of a notebook. He placed the panel atop his grandmother's living quarters and joined our congregation at the other end of the property. Daudi had recently bought the panel and, on that day, had carried it by foot from another homestead where he had been staying. He told me it was not too far away.

Embedded with portability and able to be transported to secluded areas far from city centers and established roadways, solar systems arrive in Maasai spaces and become tools interpreted for the continuation and strengthening of pastoralist life - one in which mobility plays a big part. Through people and animals, panels become mobilized in new ways. Maasai mobility, then, can be understood as a technological practice in the innovation of solar energy devices - giving the devices new spaces and new reach beyond the intent of their creators.

Solar Powered Pharmacology

Michael is a doctor of traditional medicines. I met him along a roadside in Usa River, Arumeru District in the Arusha Region of Northern Tanzania. We were both walking away from a crowded market in Usa River's city-center. I forget exactly how or why our conversation began, but I think we were drawn to each other in the mutual acknowledgement of each's unordinary appearance in a place neither of us call home. In addition to his profession as a doctor, Michael is Maasai, and thus, an expert pastoralist. His home is a multi-hour journey away, near a town called Locksale in the neighboring Simanjiro District. He lives with Matayo,

the owner of the *boma* (homestead), who pays monthly installments for a home solar system. In early June of 2018 he invited me to his home where I received my first lesson in Maasai pharmacology.

Michael took me on a walk near Matayo's boma, through the surrounding forest, alongside his herd of goats. At each step, a new medicine called his attention. This, a thick thorn from the trunk of a stout tree, treats abdominal pain in women. This, a certain plant in full bloom, treats nausea in adults. A partially-bloomed plant of the same variety teats nausea only in children. Notice how their scents are different. This, the bark of a new type of tree, treats high blood pressure. On and on we went, picking plants as we walked, with Michael discussing their medicinal qualities and the methods he uses to treat his patients. Michael told me that he has much to owe to his father for his knowledge. Since childhood, Michael has been a student of these medicines. Even today, Michael frequently returns to his childhood home to inquire from his father about new medicines.

Yet unlike his father, Michael is an entrepreneur. For two weeks out of each month Michael lives in the city on business. From Locksale, he takes public transportation into densely-populated towns and navigates to the nearest market. With this act, he transforms his knowledge and ancestral traditions into new potentialities. Here, he has customers. Off the daladala he travels by foot with his medicines stored in various packs on his person. With his cell phone, he receives calls from his vast clientele network who ask him about his inventory and his availability for an exchange. If approached by a new customer he produces two laminated menus which describe the medicines he offers. He uses his cell phone to speak with family members back home and to send them money via digital money transfer services such as M-Pesa. At two weeks' end he travels back home, reunites with his wife and children, and watches carefully over

his livestock and the young herders who he has entrusted the responsibility of his herd. He also prepares his medicines. In constant communication with his clientele, he uses his cell phone to maintain business relationships and to take orders for his next trip into the city. Matayo's home solar system enables these conversations kilometers away from the nearest connection to the national grid. Balanced between Maasai tradition and the unforgiving demands of life in a capitalist economy, Michael has carved out a unique space of his own primed for preserving the cornerstone of pastoralist life: livestock. In his own words, Michael is searching for a life.

Me: Kwa nini ulikuja mjini?

Michael: Mimi nilikuja usa kwa sababu natafuta maisha…. Na njia hii ya kutafuta maisha sio mbaya. Watu wengi… mungu akimweka mimi, watu wengi wananijua. Wengi, wengi, wengi. Kwa hiyo nina uhakika mimi nitakuja tu maisha yangu yatakaa vizuri.

Me: Kwa nini huwezi kutafuta maisha kule unakotoka?

Michael: Kule kwa wamaasai, huwezi kuwapa wamaasai huu. Kila mmoja yeye anajua. Ila hawezi…hawezi…mimi ninajua kwa waswahili nakaa na waswahili kwa muda mrefu… Mimi hiyo pesa nataka, sipati pesa nyingi. Nataka pesa kidogo tu ya familia yangu. Ya familia yangu. Anapata chakula, anaacha kuuza mifugo yao. Mtu anazidiwa kwa hospitali hamna haja anauza ngombe iko pesa kidogo. Natoa. Sasa ile mifugo inazalia tu nazaa. Halafu mimi naangalia huko kufuga. Inazuia nisipeleke mnada ngombe, mbuzi kwa ajili ya shida. Akisema iko shida,

Me: Why did you come to town?

Michael: I came because I am searching for a life…. And this way to search for a life isn't bad. Many people… God has put me here, and many people know me. Many, many, many. So, I know that I have come and my life will be good.

Me: Why aren't you able to search for a life where you come from?

Michael: There, Maasai people, you aren't able to give Maasai people this [medicine]. Each one already knows. But me, I know Swahili people. I have stayed with Swahili people for a long time…I want this money…I don't get a lot of money. I want a bit of money for my family. My family's money. [My family] gets food, we stop selling our livestock. If a person is overcome with hospital costs there isn't a need to sell a cow, there is a bit of money, it's used. Now, those livestock just reproduce. Then I look and herd them.

niko na hela kidogo ninatuma. Nina shida hii, natuma hela. Kwa hiyo ile mifugo inakaa inakula majani anafuga anatengeneza kwa dawa. Najaribu…nataka niwe na mifugo mingi kidogo.	***It prevents me from taking cows and goats to the market on account of a problem. If someone says there is a problem, I have a bit of money and I send it to them. I have this problem, I send money. So, the livestock they sit and, eat grass. I herd and make medicine. I am trying…I want to have quite a few animals.***[35]

In the words of Clapperton Mavhunga (2017a.), "things do not (always) have the same meaning everywhere; when we insist that only 'our' meaning is the 'true' meaning, we silence other people's meanings" (p. 1). By making a choice to see the Maasai as more than mere recipients of Western innovation and conservation science from abroad, we move to treat them as designers and innovators in their own right. For Michael, the home is his classroom, the surrounding forest is his laboratory, and the city is his workshop. The expertise that Michael carries is the product of a formalized system of medical knowledge that is acquired, practiced, innovated, and taught in the home and on Maasai land. Within this context – the longue durée of Maasai technological and cultural history - Michael configured a cell phone and a home solar system as technologies of Maasai pharmacology in an effort to make cheap, effective medicines available for city-dwelling Tanzanians. As a result, Michael has transformed a home solar system, a cell phone, and generations of Maasai pharmacology into an agile form of healthcare that has returned not just revenue, but resiliency to his life as a pastoralist.

[35] Interview, Michael, 5/30/2018.

Entrepreneurial Freedom

Successful Maasai herders feel severe and relentless pressure from the state, external communities, and even Maasai-born comrades to sell their cattle. Proponents say that Maasai herders who have fewer cattle will have less conflict with farmers since the amount of food needed to feed their cattle has decreased. This pressure, however, stems directly from an aesthetic imaginary of "modern" living encouraged by the state: one in which wealth is accumulated for the purpose of consumption and the "modern" person is a dependent participant in the state's organizational structures (economy, education, infrastructure, etc.).

In a conversation with an engineer from Usa River, the engineer stated that although the Maasai are wealthy people, they lack the "understanding" of an enjoyable life. Each family controls a large number of animals that, in the engineer's mind, would yeild a large monetary value if sold. The engineer's suggestion: to instill an understanding in Maasai people that enables them to sell their livestock for the purpose of enjoyment - inferred here as the purchase-able items of a "modern" life (technological products, formal schooling, cement homes, etc.).[36] Given the special relationship between Maasai people and their livestock often-overlooked by outsiders, it is no surprise that suggestions like those offered by the engineer are met with significant resistance.[37] Instead, many Maasai people have transferred talents in business and entrepreneurial ventures – which some have developed as major role-players in a transnational livestock economy which stretches from Tanzania to Somalia - to a new type of modern living.[38]

[36] Interview, engineer from Usa River, 2/04/2018.
[37] Ignoring the metaphysical relationship, Mavhunga (2017a.) states that "cattle are not means to wealth they are wealth": the enablers of prosperous futures (p. 15).
[38] During my stay with Lemta, he took me to see a goat. His neighbor is the owner of the goat and says that he had ordered it special from Somalia. It was, by far, the largest goat I have ever seen.

Pay-as-you-go plans for home solar systems and monthly bill payments for the national grid are examples of financial pressures that create tension between the metaphysical and monetary value of livestock. Alternative to the perspective of private solar energy companies, who laud their home solar systems as having the "additional feature" of income generating activities, Michael sees business as an unavoidable necessity for satisfying the monthly payments of a pay-as-you-go plan. In effect, Michael has uncovered a contingency inherent to solar electrification: that solar is not necessarily sold to ensure the ubiquity of certain human rights. Rather, much like the electric grid, solar energy is sold to encourage legible forms of production and consumption. In the quote below, Michael shares his views on Matayo's *hasara* (loss) to pay for his solar system with livestock:

Mimi nimekuja kuona kumbe inatakiwa uwe na biashara ya kufanya. Kwa sababu yule mzee anachukua ngombe sasa, anauza kulipa ile deni. Badala ile sola inalipa yenyewe: anafungua biashara yake na hiyo sola. Sasa yeye hajafanya hiyo ameweka sola kuwasha taa, basi. Nachargi simu tu inatosha. Sasa yeye ana hasara. Hiyo ni hasara. Mwengine ananunua ana biashara yake, ana salooni kidogo pale. Iko duka yako kidogo. Labda anaweka chargi. Kwa hiyo hela yake iko hapohapo. Ya kulipa, yeye analipa yenyewe…Sio anauza ngombe yake.

I have come to see that, in reality, you are supposed to have a business with your solar system. Because our elder sells his cows to pay the debt from his solar system. Instead of the system paying for itself: to open a business with the solar system. Now, he hasn't done that, he has put a solar system and uses its electricity. He just charges his phone and it's enough. He has incurred a loss. Another person buys a home solar system and has their own business, they have a small saloon there. A small shop. Maybe he charges other people's phones. So his money is right there with his solar panel. He pays with his solar system…not by selling his cows.[39]

[39] Interview, Michael, 5/30/2018.

For his own solar system, to be bought in the future, Michael has different plans:

Me: Kwa hiyo, je, unafikiri utanunua sola?

O: Mimi nanunua lakini bado. Nataka nijenge, kule nijenge, nipate kufungua biashara kule kijijini. Napenda sana niweke sola. Lakini najua hiyo sola nililipa. Asilimia. Ile, kuna ya kununua cash na kununua kwa mkopo. (22:59) Sasa ile ya mkopo ni nzuri kwa mtu anayependa biashara. Unachukua, unalipa kidogo kidogo, hiyo ni nzuri pia… Inaniwezesha kwa sababu nikifanya ile biashara ya dawa ya mifugo, pale nimeweka chargi na nitafanya biashara. Ile sehemu sio giza. Mtu anakuja saa yoyote, inawaka taa, naweka charger ananunua, salooni hapo hapo, iko hapo. Basi inalipa. Inalipa. Nitailipa. Sio sawa na ile unaweka tu, hauna biashara yoyote, inakaa halafu unauza ngombe... Unafungua biashara yako, duka la salooni unanyoa, chargi iko hapo, watu wanakuwa wanalipia simu. Halafu na duka ya dawa ya ngombe. Inalipa.

Me: So, do you think you will buy a solar system?

O: I will buy one but not yet. I want to build an office there in the village and I want to open my own business. I would like to use solar but I know that I'll have to pay for it. There are systems to buy with cash and others to buy with a loan. The one to buy with a loan is good for a person that likes business. You get it and you pay bit by bit. That is also good…Solar enables me because if I start the livestock medicine business, I would have put electricity and have started to run my business. It shouldn't be dark. A person is able to come at any time, lights are on, I charge their phone, there is a saloon there. And the solar system pays for itself. Not, okay, you install the solar system and you don't have any business, it just sits there and you sell cows... You should open your business, a saloon where you cut hair, charge phones that people pay for. And then the livestock medicine shop. It pays.[40]

[40] Ibid.

Michael's ambition to open a livestock medicine business is a mixture of his two passions: livestock herding and pharmacology. Intimately tied to this dream is an imaginary of "business" itself: a freestanding structure with bright lights that extend business hours into the night, allowing fellow community members to take advantage of his services at all hours. Inside the shop there will be small machines - like hair trimmers and USB ports - whose paid services contribute income used to pay the monthly bill of a payment plan of a solar system that provides the electricity necessary for a proper shop.[41]

Michael's entrepreneurial efforts are evidence of his readiness to adopt tactics and techniques poised to better position himself, his family, his livestock, and his pastoralist dreams to succeed amidst changing social and economic circumstances. By accepting the vulnerabilities inherent in capitalist entrepreneurship – which involve financial risk, tireless effort, personal sacrifice, and cultural transformation – Michael has helped pave the way for new conceptions of contemporary Tanzanian society and for the devices he wields. Maasai merge imaginaries of income-generating futures with tradition and autonomy in the creation of innovative new spaces for capitalism, technology, infrastructure, and pastoralism to coexist.

Remote Disconnect

Some Maasai people have taken to rejecting the form of revenue generation enabled through the repossession of home solar systems. Maasai people give their solar systems new lives in the activation of human mobility and communal networks of inter-household exchange. When a homeowner has been overcome by monthly loan payments for a home solar system they will search for members of their community who are willing and able to continue their payments.

[41] Ibid.

When an accepting household is found, the solar system is transported to its new location where it will continue powering other members of the community. The head of the accepting household will continue paying the monthly loan payments and will give to the head of the donating household a monetary value equal to the amount of money they have already invested in the system - in other words, a value equal to the amount of money that would have been lost had the solar energy company come to repossess the system. This value is transferred as livestock or digital/physical currency.[42]

Livestock Protection

"Cattle have a unique and essential role in Maasai culture. Community position, nutrition and food security, personal wealth, and cultural practices are all intimately intertwined with cattle. From a young age, boys learn to herd cattle, while the warriors provide security and guard against threats, including attacks by lions. One Maasai prayer highlights the importance of cattle: Meishoo iyiook enkai inkishu o-nkera*, or in English, May Creator give us cattle and children." (Mittal, 2018, p. 11).*

In almost all of my interviews with Maasai people, solar energy was praised for its ability to protect livestock during the night. Predatory animals such as lions, leopards, and hyenas, which inhabit the secluded grazing environments traditionally sought by Maasai herders, present a legitimate threat to livestock safety. The threat is especially real at night, when these predatory animals use the cover of darkness to invade Maasai bomas and steal small members of the herd. Such is what happened to Matayo, and served as his foundational reason for purchasing a home solar system. A leopard invaded his boma during the night and killed two goats. Now, two solar powered bulbs cast a bright light upon his herd from dusk until dawn.

[42] Ibid.

Figure 3. Matayo's livestock security module.

Maasai people's appropriation of home solar systems as livestock security modules is situated within the longue durée of Maasai technological and cultural history that has dedicated itself to ensuring livestock safety. In years past, Maasai *moran* (warriors) – the aspiration of every Maasai male child and the symbol of security and integrity for Maasai communities at large – were instructed to kill lions, the cow's most feared predator, as a rite of passage marking entry into adulthood. Above all, it is the duty of the *moran* to protect their people and their cattle, the sacred possessions of their families (Masolo 2017, p. 35).

Such sacredness I will not attempt to fully characterize here. Rather, I want to theorize energy as part of this sacredness - that necessitates transformative measures for livestock safety - and understand the dynamic energy regimes at play for Tanzanian Maasai of which this electric form of solar energy is newly a part. In *The Organic Machine*, Richard White (1995) underscores the connection between human labor and the "energy of nature" as a productive link for understanding human beings' entanglement with the world. White points to the evolving energy regimes that govern the Columbia River, its salmon, and its human inhabitants to suggest

that ecosystems are “organic machines” that have been, and will continue to be, inextricably tied to human labor and human energy: “the nature within us” (White 1995, p. 112).

The equatorial sun which passes over Tanzania’s northern plains is a constant source of energy whose gravitational field and electromagnetic waves perpetuate a mosaic of natural mechanisms set in continuous motion. The sun evaporates water from tropical rainforests, lakes, rivers, and oceans and produces winds that carry the moisture over land. The rains fall and become intertwined with the sun’s rays once again: the mixture spurring growth in plant matter of various forms and sizes. The sun’s year-long cycle builds, nourishes, destroys, and builds again the plains’s natural foliage – the foundation of an ecosystem electric with life.

When Maasai people migrated to the region, the organic machine would forever change. Maasai cattle, with their special mixture of physical traits – small diafram, leight weight, resilience to disease, large hooves, aerobic endurance – are uniquely adept at transforming the plains’s fluctuating ecosystems into muscular potential, and eventually, caloric energy (milk and meat) for their human counterparts. They are, in one sense, a biological energy source appropriated for energy storage and energy conversion – an energy technology.

For carnivorous lions that feast mainly upon grazing herbivores, Maasai cattle emerged into the world as a source of energy for their own pursuits. The cow’s energy potential ties Maasai people and lions together, a tensious relationship that has become manifest in the cultural practice mentioned earlier in this section – the righteous killing of lions - that is now outlawed by the state. By attending to the energetic aspects of Maasai cattle, livestock safety can be understood as labor, a type of work, that connects Maasai people to their cattle, animal predators, and the ecosystem at large in ways unrecognizeable to many outsiders of Maasai communities.

In *Animal Intimacies*, Radhika Govindrajan (2018) comments upon *relatedness* between humans and non-human animals, writing that "human pasts, presents, and futures are gathered with the pasts, presents, and futures of the multiplicity of nonhuman animals who share worlds with them" (p. 1). I have draw upon the work of Richard White to suggest that part of this relatedness comes from ever-evolving energy regimes of which human work is a part. In Maasai communities, livestock safety is situated within a longue durée of Maasai technological and cultural history as a type of human work that constantly negotiates its place within evolving energy regimes. Maasai-deployed solar energy devices are only the most recent iteration: itself a reconfiguration of the vast natural cycles of the planet, now channeled into a piece of technology created and deployed by human labor, to protect solar energy with solar energy as Maasai people have always done before.

A Pastoral Future

Foreign tourists who visit Tanzania to see wild animals and vast landscapes fuel an economy whose strength rests on violence against Maasai people. Natural resources are aestheticized and commodified through logics utilized by colonial regimes wherein conservation and development are only possible under the control of Western authorities. Of course, history is tenuous and economic and political factors are complicated. But those proponents of the national park and game reserve system as it operates today have convinced themselves of local peoples' inability to protect resources on which they have relied for hundreds of years. Within this paradigm, violent evictions of Maasai communities from the Serengeti and Ngorongoro Crater – that have included the burning of homes, the killing of livestock, and, sometimes, the murder of

people – are touted as just strategies in the state's fight against "environmental degradation" (Mittal 2018, p. 18).

I want to argue that these crimes are made possible by stripping Maasai people of an essence of their humanity – namely, their ingenuity. Their finely-tuned conservation and pastoralism practices, and their capacity to innovate more broadly, is intentionally disregarded in favor of a "stubborn" and "backwards" people. In the end, Maasai people are commodified themselves.

My recounting of Maasai innovations of solar energy is intended to disrupt the aforementioned – to depict Maasai pastoralists as innovators and technologists as they electrify their communities in an effort to strengthen pastoralist life: a life that, today, includes not only a large and healthy herd, but cell phones, social media, digital currency, music sharing platforms, and selfies. Maasai people are modern and configure their traditions along with inbound materials and ideas in the effort to ensure a pastoralist future in Northern Tanzania.

The accounts of Maasai innovations of solar energy – including solar energy's history in Maasai communities – that are shared in this section show how embracing the risk of vulnerability can facilitate novel understandings of the old and the new, and of the balance between the two. I want to suggest that it is only by eliciting risks of vulnerability from the Tanzanian state and international development institutions that the injustices of an economically, politically, and socially "safe-inequality" can be laid to rest (Parreñas 2018, p. 41).

I hope that my presence throughout this essay can serve as a sort of evidence for this. I struggled to learn a new language, I tried my hand at herding, and I experienced empathy in friendships forged through the bi-directional exchange of stories. In a way, I'd like to believe that the transformation that has occured in my character and in my perspective over the course of

this thesis proves the efficacy of diverse partnerships made possible through the risk of vulnerability. If I can take seriously lessons in pastoralism from young Samson, can the national government and international development institutions also learn to take seriously their constituents? Could the tourist industry change the context of cross-cultural interactions that it facilitates? Could rigid terms of contract be swapped for rigid terms of understanding? And could colonial power dynamics be swapped for novel partnerships? By asking these questions, we put longstanding meanings of "modern energy," "conservation," and "development" in jeoporady. Indeed, this is just the risk we have to take.

Clapperton Mavhunga (2017a.) writes that in the face of adversity and against seemingly insurmountable odds, "the human spirit does not just roll over and die" (p. 13). For Paulu, an entrepreneur in Arusha, Tanzania, creativity and innovation comprise an inalienable lifeline that he does not surrender to state policy nor international declaration. Before May of 2018, he was the proprietor of a small shop along the main road leading from Arusha, past Kilamanjaro Airport, to the city of Moshi. At his shop, he sold small items used for detailing cars and motorcycles: license plates, stickers, and the like. A new measure implemented by the state required Paulu to purchase an electronic receipt machine, a device that would require Paulu to pay a tax for all products sold in order to keep his place of business. Unable to pay this tax and ensure an adequate living, Paulu abandoned his stationary shop in favor of mobile refuge. Mobilized by public transportation, Paulu provides on-site detailing services to clients throughout Arusha. In recounting his choices, I choose to acknowledge that creativity and innovation arise from the Tanzanian experience in inspiring ways. The Maasai are not the only group who feel crushed by state agendas, nor are they alone in their struggle to retain autonomy.

Out of collisions between disparate people and objects, tireless innovation solidifies the possibility for technological futures buttressed by the intellect and sacrifices of ordinary Tanzanians.

Chapter 5: Energy Technology Chorus

"Innovation is borne of freely thinking citizens who, as part of their own communities, identify with the values, directional goals, and challenges and struggles that stand as obstacles to these ends. In other words, innovation comes out of different levels of participatory discourse about prevailing needs and about available local human and material capacity to tackle them." – D.A. Masolo (2017, p. 36)

Electricity is situated within a longue durée of technological history in which Tanzanian people satsfy energy needs before, during, and after colonial rule. Light, safety, connectedness, and economic standing appear throughout this history in varying capacities. The technologies and innovations that meet the ends of Tanzanian desires appear uncharacterized by dramatic narratives of liberation and dominance. Just as these technologies and innovations do not entirely embody the ideal aesthetic of an industrialized nation propagated by international development organizations and the Tanzanian state, nor do they not suggest a "stubborn" peasantry devoid of any contribution to community development. The fragmented stories of this chapter, told to me by friends and community members of Usa River and the surrounding regions, present technology as "a means of performing specific projects of one's own" and innovation as an ordinary process grounded in careful and concerted experimentation (Mavhunga, 2014b., p. 16).

The first energy technology that appeared in my conversations with Tanzanians is called *kijinga*: a light source fashioned from the branch of a special type of tree. The wood, hard in its composition, produces a small, contained flame when ignited at one of its ends. The wielder of the kijinga waves the branch back and forth to add oxygen to their mobile combustion reaction and to illuminate an area of interest. The hard wood of the kijinga burns slow and constant, allowing for continued illumination far from the immediate vicinity of the nearest fire or in the

absence of a full moon. In the rainy season, the branches used to create the kijinga become wet and a different lighting technique is used:

Kuna ile miti nyembamba ile migumu. Ile miti migumu unaweka katika ule moto mwengine kwa ule mti mwembamba lakini migumu. Unatumia kama, kinaitwa kijinga cha moto. Kwa hiyo unauambikia tu unamwalika…Na baadaye wakati wa masika tuna ile tunakula, miwa, ile sugar cane, lakini sasa ya asili ya mitana. Tunakula halafu tunatunza zile maganda yake yanakauka. Kiangazi tunakausha vizuri baadaye tunatumia ndani kama koroboi, unawasha unakwenda kuleta vyumbo huko ndani, au unakwenda kuangalia kama kuku wameingia ndani au kama ndama ni wengi babu anataka kujua kila ndama akaingia sehemu yake.	***There are skinny trees, the hard ones. Those hard trees are placed in the fire. It's called fire kijinga. So, you just illuminate with it... And later during the rainy season we have sugar cane. The natural type. We eat it and then we save the outer layer and it dries. In the summer, we dry it well and later (in the year) we use it inside like a lamp. It's lit and you go to fetch tools to bring them inside, or you go to see if the chickens have gone inside. Or if there are many calves, Grandpa wants to know that each calf has gone to its place.***[43]

Later, conversations of energy become dominated by *mafutaa taa* (light oil) in the form of tin lamps called *koroboi* and *kandili*; kerosene in two forms called *chemli* and *karabai*; and *mshumaa* (candles). In tough times when the price of light oil was too high to afford, tractor and car tires were repurposed as cheap lamps which had long lifetimes compared to the more expensive koroboi and weaker mshumaa.

[43] Interview, Bibi E., 1/11/2018.

Haya matairi ya tractor, matairi ya magari watu wanachonga wanatengeneza kama mshumaa. Wanachoma na ile ilikuwa ni mfumo ambao watu wengi walikuwa natumia kwa muda mrefu kidogo kwa sababu ni kitu kisichoisha haraka.

These tractor tires, car tires, people chop them up and fix them like candles. They burn them and it was a system that many people were using for a long time because it was a light that didn't burn out quickly.[44]

Burgeoning international relationships supplied ordinary people with new materials, techniques, and opportunities for innovation. Discarded cardboard was noticed to burn strong and slow after being soaked in water and was subsequently adopted as a cheap and reliable cooking fuel. Coca-Cola's chemical make-up is repurposed by motorcycle mechanics as a cleaning agent capable of removing carbon from battery terminals. Technologies capable of converting biomass into combustible methane gas arrived in East Africa via foreign organizations but took on new forms in Tanzanian hands. A certain Mr. Mungure of Tengeru, Arumeru District, Arusha Region is famous in his community for having built a biomass-powered tiller from a motorcycle engine. The same technology was used by a college-educated neighbor of my friend, Mama J.. She describes seeing the manure-made "electricity" as the work of a man with divine intelligence.

Nakumbuka ndipo nilipokuwa mdogo kuna mzee mmoja walikuwa wakimwita Mungu Mtu. Walikuwa wakimwita Mungu Mtu kwa sababu yeye aliweza kutengeneza umeme kwa kutumia kinyesi cha wanyama. Alikuwa nafuga ngombe na nguruwe na alikusanya kile kinyesi chao… Alitengeneza umeme na

I remember when I was little there was one elder that people called God Person. They called him God Person because he was able to create electricity by using animal manure. He was raising cows and pigs and collected their manure…He created electricity and while the people were using his electricity they

[44] Ibid.

watu walikuwa wakitumia umeme wanasema, kwa sababu wananchi walikuwa, wanakijiji walikuwa hawaelewi kutengeneza umeme kwa njia ya kinyesi, kila mtu alisema huyu ni mungu, ana akili za mungu, yeye ni mungu mtu. Walimwita mungu mtu kwamba ni mtu akiwa nafanya mambo makubwa kama mungu.

were saying, because the villagers didn't understand how he created electricity by using manure, each person said this person is like God, he has the intellect of God, he is God Person. They called him God Person because he was a person that did big things like God.[45]

Divinity exists in curious places as people guide everyday materials through processes of careful and concerted experimentation focused on the discovery and appropriation of energy resources:

Zamani tulikuwa tunaweka battery, tunaunganisha battery, battery nyingi, tunapata umeme. Tunaweka bulbu ndogo zile za torchi, tunapata mwanga. Tukawa zikawa zinaisha charge. Tukawa tunaziingiza chooni, kwenye choo tuna…hatuzifikishi kwenye uchafu, tunazininginia vile zinapata charge. Zikawa zinapata charge. Tukawa tukiziunganisha bulbu inawaka kwa nguvu. Halafu unasikiliza mziki, unasikiliza radio, unasikiliza mziki.

Tukakaa tukakaa tukakaa, tukaona zinaisha charge, tukaziweka juu ya paa zikapigwa na jua. Zinapigwa na jua jioni ukiziunganisha unapata. Kwa hiyo chanzo cha sisi kupata nishati kila siku tulikuwa naangalia ni jinsi gani tunaweza tukapata nishati ya umeme?

A long time ago we would place batteries, connecting many together in series, to get electricity. We would place a small bulb, the ones in hand-held torches, to get light. Then they would run out of charge. So, we hung the discharged batteries in latrines, above the waste at the bottom. They didn't touch the waste. We hung them like this and they became charged. When we again connected a bulb, it would shine with strength. Then you listen to music, you listen to the radio. We sat, we sat, we sat, we saw that they ran out of charge. We placed them on the roof where they were hit with the sun. All day they were hit with the sun and in the evening if you connect them together you got [electricity]. So, each day our sources for

[45] Interview, Mama J., 2/22/2018.

> ***getting energy were looking and asking in what ways can we get electricity today?***[46]

As I have already suggested, the answer to the interviewee's question, posed above, is not always the national grid. Expensive monthly payments for grid electricity were once avoidable with technical skill, strong personal relationships, and a bit of risk. In *Emergency Power: Time, Ethics, and Electricity in Post-colonialist Tanzania*, Michael Degani writes about the state of electric *ujanja* (trickery) in the nation's largest city, Dar es Saalam. In response to state reforms that rendered electricity less affordable and reliable at the very moment its economic and cultural significance was expanding, an informal collective of *vishoka* (hatchets/conmen) and *mafundi ya mtaani* (street engineers) organized to manage the economic crisis. With a variety of skillsets ranging from the technical to the persuasive, *vishoka* and *mafundi ya mtaani* worked within and around Tanzania Electric Supply Company Limited (TANESCO), Tanzania's national energy company, to bring electricity to the people quicker and more affordably – albeit at the state's expense. Degani (2013) writes:

> *At the bottom are magundi ya mtaani…These technicians might scrape by a living with small-scale repairs of frayed cables or broken electrical appliances, or find wiring or installation work in the big hotels and compounds that are popping up with Dar's construction boom. Yet they might also be persuaded to expedite a service line application to TANESCO or illegally reconnect an indebted household to the grid…Either through informal apprenticeships or friendships, mafundi ya mtaani partially overlap with TANESCO vibarua (day laborers/messengers). TANESCO hires vibarua on short-term renewable contracts for about three dollars a day, working as line men, meter men, or drivers…Vibarua, with their uniforms and access to TANESCO vehicles and ladders, sometimes partner with street electricians to tamper with*

[46] Interview, Baba Z., 4/17/2019.

meters, providing a measure of discretion against the prying eyes of neighbors or the police…The top tier of electrical work concerns salaried workers with secure employment and benefits…[Salaried workers] are in some ways bolder about pursuing sideline revenues. Inspectors may be negotiated with on the spot not to disconnect an indebted or tampered meter, which sometimes evolves…into an ongoing quasi-protection-racket relationship (p. 186).

In response to electric ujanja – specifically, the technical modifications made to TANESCO meters by *mafundi ya mtaani* - TANESCO implemented a new electricity metering system called LUKU. Similar to previous meters in the way they measure the amount of electric power used by a household, LUKU meters are placed high upon nearby electrical poles, outside of the reach of *mafundi ya mtaani*. The LUKU meters are accessible to electricity consumers and TANESCO bill collectors via digital, remote control technologies. The implementation of the LUKU metering system strengthens TANESCO's grip on electricity consumers. An effort in achieving the state's imaginary of a grid-connected citizenry – obedient, paying dependents - the LUKU system effectively disrupts a single form of citizen-led resistance to state-controlled electricity. The result: a strong desire for alternative energy systems in grid-connected communities.

In an escape from the financial burden imposed by the electric grid, some Tanzanians have sought solar to satisfy their demands for reliable electricity in the home. Solar's appearance at a household is common both before and after a household's connection to the grid - serving to fill the void of grid electricity and avoid costly installation fees or to decrease monthly bill payments sent to TANESCO. Independent of foreign solar energy companies and state-sponsored electrification projects, ordinary Tanzanians have worked alongside Tanzanian solar energy entrepreneurs to electrify their own communities. Surprisingly, these Tanzanian solar

energy entrepreneurs are virtually absent from international development discourse, despite the fact they are educated in electrical engineering principles – either in the form of short courses, apprenticeships, or hands-on experience – and proactive about sharing their knowledge of home solar systems and their proper maintenance to local communities (for a longer excerpt from my conversation with the Tanzanian solar energy entrepreneur introduced below, see Appendix C).

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Me: Kwa hiyo wewe ni fundi na muuzaji.	***Me: So you are an engineer and a shop owner.***
S: Fundi na muuzaji. Wanapokuja wateja kuna namna wanaweza…anaweza kununua, akaenda akafunga mwenyewe. Ama akipenda tunamfungia sisi. Na mimi ninakuenda, namfungia, fanya wiring kulingana na bulb anazozitaka, namaliza. Mimi pia wakati mwingine, sisi hapa, tunakwenda vijijini, tunaeleza watu kuhusu umeme wa sola, wananunua. Ile ne njia ya pili. Njia ya tatu, sisi hapa, mimi, nakwenda vijijini, ninaendesha seminar juu ya matumizi mazuri na sahihi ya sola..Hata kama ananunua au hanunui lakini tunawaeleza.	***S: An engineer and a shop owner. When customers come there are ways that they are able to…they are able to buy their system and go and install it themselves. Or if they like, we can install their system for them. I go, I install their system, I do the necessary wiring for the number of bulbs they want and I am finished. And other times, we go to the villages and teach people about solar electricity. And they buy our solar products. That is the second way. The third way is that we go to the villages and I organize a seminar on proper uses of solar systems…Even if they buy or don't buy our products we teach them.***[47]

The spread of knowledge through person-to-person interactions - combined with the simple presence of solar energy systems and a strong desire for cost effectiveness - invites many solar energy users to become self-taught experts themselves. During my time in Arusha I became

[47] Interview, Solar energy entrepreneur, 3/09/2018.

close friends with a man named Laurent. Laurent works at the university where I was studying Swahili and shared an interest in electrical systems. He showed me around his neighborhood, where two hydroelectric dams had been built, and to his home, where he had installed a home solar system to supplement his connection to the electric grid. Despite my training in electronics gained through college-level coursework in an accredited engineering program, Laurent's understanding of his home solar system far surpassed my own. He had configured a system of four batteries in parallel which were charged through a charge controller by a single solar panel placed on the roof of his home. In total, the energy produced from his solar system powers nightly cell phone charges and multiple lights throughout the home – including those used to feed his chickens during the nighttime. The electric grid powers his television set and speaker system.

The solar systems deployed by Laurent and others like him illuminate a solar energy sector driven by the innovations and resourcefulness of ordinary Tanzanians, not foreign capital, terms of contract, or rigid imaginaries of development. Laurent has also inspired his neighbors and work colleagues to satisfy their energy needs in the same way: travelling to their homes and offering his own technical expertise in the configuration of home solar systems whose components are bought from local solar energy entrepreneurs. Considering the grid and his solar system together with the gas Laurent buys to power his stove, Laurent operates a cost-effective and reliable, multi-source energy system in his home with the option of complete independence from the national grid.

The prerogative for rising energy engineers and energy business leaders is to interrogate the dominant narratives of energy development which consume our imaginations of the future. For within these imaginations lay biases against technologies, philosophies, and innovations

coming from ordinary Tanzanians that are poised to re-orient energy as an egalitarian tool for collective development. The *mafundi ya mtaani* demonized by TANESCO officials reduce e-waste in the repurposing and repair of electronic materials. They are also the foundation upon which electrical engineering training is given, learned, put to use as the trade of individual entrepreneurs, and re-taught to young neighbors.

E: Sikutaka kuondoka na huu ujuzi kama mimi. Nilitaka niwekeze kwa baadhi ya watu…Niliweza kumchukua kijana ambaye alikuwa amefaili baada ya kufika Form 4. Kwa hiyo akafaili alikuwa hana matumaini. Nikaamua kumchukua yule mtoto, kumsomesha, yaani kumfundish ujuzi nilioko nao. Na mwaka huu, nilikuwa na furaha kubwa sana baada ya kumshukuru Mungu, kwamba huyo mtoto alihitimu baada ya kukaa naye kwa miaka mitatu na nusu. Ameweza kuwa fundi na ameweza kufungua ofisi yake…Na yeye anakwenda na spidi yangu hivyohivyo tunavyokwenda. Yanayomshinda, anakuja, 'hapo tufanye nini?' Ninamwelekeza. Na kingine kwa kuhamisisha vijana. Sasa hivi ninao vijana watatu ninaowafundisha. Ambao wako darasani mpaka sasa hivi. Kwa hiyo ina maana nikikamilisha hawa watatu, nimewalea katika hali ya kuwafundisha kwamba kitu ulichokipata kwangu usibaki nacho. Umfundishe na mtu mwengine.

E: I didn't want to leave with my experience all to myself. I wanted to invest in people…I was able to take a teenager who had failed high school. He failed and didn't have any hopes. I decided to take him in and teach him the experience that I have. And this year, I was very happy after thanking God, that that kid finished his training after staying with me for three and a half years. He has become an engineer and he has been able to open his own office…And he is going at the exact same speed that we are going here. For things that best his ability, he comes and asks 'what should we do here?'. I direct him. And something else about motivating teenagers. Right now I have three teenagers that I am teaching. That are still in training. It means that when I have finished teaching these three students, I have raised them to understand that the things they get from me they should not keep to themselves. They should teach other people.[48]

[48] Interview, Engineer from Usa River, 2/04/2018.

Given a tough job market often-characterized by unemployed youth, what new conceptions of a modern, technological, and prosperous society could evolve from investing in people who are finding connections between engineering, local resources, and eager intellects?

Conclusion

> *Bibi E. works at the university which facilitated my Swahili studies. She was born in the Manyara region of Northern Tanzania, the home of the only site of convergence of the four indigenous ethno-linguistic groups of Africa. Unlike her mother's side of the family, which has lived in Manyara region for generations, her paternal grandfather came to Tanzania from Somalia: a refugee fleeing conflict. Upon arrival in Manyara region, he was accepted by the Fiomi people and began a new life. An expert pastoralist and dependable intellect, Bibi E.'s grandfather assured the wellbeing of his new family with a dedication to his livestock and built rapport with local institutions by contributing to post-independence government projects in the region. He is remembered by his descendants and the descendants of fellow community members as a man unshakeable in his commitment to helping others and to living at peace with the environment. For this, Bibi E. says that her grandfather would have used solar energy. In her words,* "hakutaka kupoteza asili yake" (*he didn't want to lose his natural self).*[49]

Deep in the clean rooms of well-funded research laboratories, electrical engineers and materials scientists use abstract and creative methods to construct new, high-performance photovoltaic (PV) cells: the foundation for all solar energy systems.[50] Each scientist develops their own trade, described to me by a seasoned practicioner as a sort of "black magic," over the course of a career: chemicals altered, substituted, and deployed almost nonsensically for improvements in cell efficiency and lifetime.[51] The latest PV innovations, then, are a product of the collective and compounding discoveries of (usually) Western and East-Asian scientists experimenting loosely and creatively in built-laboratories. From their very beginnings, solar

[49] Interview, Bibi E., 1/11/2018.
[50] These cells are the medium in which interplanetary photon is converted to terrestrial electron.
[51] Interview, Photovoltaic materials scientist, 2/10/2019.

energy PV cells are shaky and unstable – guided by methods of trial and error performed by experienced practicioners.

In the hands of state-sponsored institutions and foreign companies, solar energy systems are endowed with order and rigidity. Individual PV cells are fabricated en masse on factory assembly lines and set within an expansive grid of PV clones. Interconnecting these cells with highly conductive materials – usually aluminum and silver – ensures that the electrons ejected from the collision of photon and crystalline silicon travel through pre-determined pathways with the greatest of ease. They emerge into the digitizeable world carrying voltage and current values that are processed and regulated by a charge controller to ensure that the system's battery is charged at just the right speed and to just the right amount. Tied to specific uses (e.g. traffic lights that govern the flow of motorists on state roadways) and governed by specific regulations (e.g. rigid terms of contract that ban "tampering" with one's module) solar energy systems can be configured as extremely effective tools of empire.

But in Tanzania's Arusha Region, ordinary people put solar energy devices to work – *their* work. In *The Mobile Workshop: The Tsetse Fly and African Knowledge Production*, Clapperton Mavhunga (2018) shows how inbound gadgetry becomes technological only through a process of appropriation and experimentation guided by the knowledge and experiences of the people who deploy it to perform specific tasks.[52] Despite intended functionally, solar energy systems are workshoped by ordinary Tanzanians whose knowledges are continually produced on the cutting edge of technological and cultural histories endogenous to their own communities. For Maasai people and Arusha city dwellers, the pasture and bustling city streets can be

[52] Mavhunga writes this book situated in the philosophies and vocabulary of chizimbahwe, a group of languages used in and around present-day Zimbabwe. I am unable to replicate this methodology here and throughout thes thesis.

understood as transient workspaces where people import the knowledges of foreign engineers, embodied by PV materiality, and proactively negotiate their place alongside locally-defined goals and value systems (Mavhunga 2014b.). Ordinary people experiment with the manipulation of gadget and tradition to create new ways to be pastoralist, doctor, entrepreneur, educator, and electrified in contemporary Tanzanian society.

By attending to the sociotechnical imaginaries of solar energy held by ordinary people, I have revealed the various ways solar energy is imagined in good and attainable futures. I have also suggested that by embracing risks of vulnerability, conceptions of solar energy that oppose imaginaries held by the dominant powers of the day can be oriented to fuel meaningful development initiatives. And finally, by exploring the link between Maasai pastoralism and solar energy technologies, I have argued that there is room for disruption and renewal of conceptions of *both* in collaborative imaginaries of technological, innovative, and "modern" futures.

At its core, this thesis is about knowledge production. It is about where knowledge comes from. It is about who knowledge comes from. Rather than lament on the criminalization of Maasai knowledge in the Serengeti and Ngorongoro Crater, I have shown how Maasai people have shown creative resilience in their production of uniquely-Maasai forms of solar energy knowledge. As opposed to beneficiaries or mere weilders of inbound innovation from abroad, Maasai people are key intellectual agents who have transformed solar energy, its meanings, and its associations vis a vis a commitment to their own development agendas.

Mavhunga writes, "The problem is not with science, technology, and innovation but how it is defined in alienation, such that Africans are made to enter as unsure and trembling visitors to other societies' achievments" (Mavhunga 2017a., p. 2). The demand posed here is to

acknowledge positive Africans – creative, technological, and scientific in their own way. Maasai people are but one such example: proud in tradition and potent in innovation. The potentialities of black magic solar cell fabrication, combined with the encouragement of innovations coming from ordinary people, create conditions of infinite solar possibilities. The story of Bibi E. and her grandfather included at the beginning of this section evinces the multitudinous ways people, with their values, ideas, and histories, might come into contact with these possibilities - spurring new values, ideas, and histories in the process. Bibi E. and her grandfather now live on in these pages. Although told to me briefly, their story has stuck - a sort of symbol for *my* imaginations of the world: evidence of the possibilities that lie ahead and the terms that might manifest them. A pastoralist refugee's determination to live with the natural environment and contribute to the construction of a stable foundation for Tanzania's independent government has spawned dreams of solar possibilities in the imaginations of his descendants.

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Appendix A: Conversation with founder of e-waste company.

Me: Is the environmentally-friendliness of solar energy in question? (16:34)
A: I would say there is a big question mark. But that is not specific to the solar industry. That's generally how our world economy works…How our world economy works is that we are not paying for the environmental cost of our products up front. If you look at your phone, which is a great example, it has a lithium battery which is probably mined in Argentina. It has cobalt which is mined in Congo. It has a very limited material that starts with a 'T' which enables the touch screen technology. By various estimates it will run out in seven to fifteen years from now, we are running out of that. It has aluminum, it has plastic that is derived from oil which is drilled. The number of materials that go into this technology are from literally around the world…You have products coming in to China. It's manufactured. It's then shipped [to Africa]. I bought it in Rwanda. It's used in Tanzania. It's disposed of, if I'm lucky, in Europe. But probably in Tanzania. Where then it's separated and the parts go to Belgium, go locally, some go to China. The circuit board might even go to Dubai. And then it's shipped back to China. The plastic might be disposed, go into the ocean, and end up in Indonesia. When I bought this phone, none of the environmental costs were calculated into the cost of the phone" (19:29).

Appendix B: Conversation about the government's solar projects

Serikali sasa hivi inawekeza sana kwenye huu mfumo wa umeme wa REA kwenye jamii maskini lakini wakati huu serikali hii hii yenyewe inatoa umeme inawekeza kwenye mfumo mbadala wa nishati. Na mifano mimi ninayo. Ukienda manisipaa, ukizunguka kwenye street zote za manisipaa wanawekeza, wanaweka sola. Ukienda mataa ya matraffic sasa hivi wanatumia sola. Ukieenda barabara hizi za airport na kila mahali wanatumia sola. Ili serikali kuu, ni serikali ninaizungumzia. Ambayo ndio yenye uwezo wa kutumia nishati ya Tanesco lakini serikali hii hii inapeleka umeme huo wa REA kwenye jamii maskini ambayo ikiwawekea hawana uwezo endelevu wa kuweza kulipia umeme huo. Ambalo nilifikiri, ni kitu kizuri kwa maana ya watu kujiajiri katika jamii mbalimbali na huko vijijini kama kuanzisha viwanda vidogovidogo. Lakini wangeweza kuitazama kwa pamoja kwamba tunaweza tukaweka viwanda hivi kama machine za kusaga, tukaweka na hivi, kuwepo na mifumo yote kwa pamoja. Ili kuona tanzania yenye mwanga kwa pamoja…

Right now, the government is investing a lot in the REA system in poor communities but at the same time that this very government is offering electricity, it is investing in an alternative energy system. I have examples. If you go the municipal office building, if you go around all of the streets near the municipal offices they have put solar panels. Traffic lights use solar energy. If you go to the airport, everywhere there is solar. This is the head government I'm talking about. It has the ability to use Tanesco electricity but this very government is taking REA electricity to poor communities whose people don't have a sustainable way to pay for it. I thought about it, and it's a good thing for people to employ themselves in various communities and there in the villages, like starting small factories. But they should look at it together, to see that they are able to put these factories like milling machines and others, with all the systems there together. In order to see Tanzanias get light together*….*

Appendix C: Conversation with solar energy entrepreneur.

Me: Ile njia ya pili, unawaeleza watu umuhimu wa sola. Katika maoni yako umuhimu wa sola ni nini?
S: Sola ni nishati ya nguvu ya kujipatia mwanga na kuendesha machine mbalimbali. Kwa hiyo umuhimu wake ni kuendesha machine na mwanga. Na labda niendelee ndani ziadi, kwamba umuhimu wa sola kulinganisha na umeme una faida nyingi. Sola haziharibu mazingira… haina madhara kwa mazingira. Na gharama ni za chini kiasi fulani. Sio…unaponunua ni gharama juu kidogo lakini hakuna bill ya mwezi. Huu ni umuhimu mojawapo…wa pili. Lakini umuhimu wa tatu na ndio wengi wanaotumia, sola inafuka kule ambapo umeme wa taifa haufiki.

Me: The second way, you explain to people the importance of solar. In your opinion, what is the importance of solar energy?
S: Solar is a strong energy that provides you light and the power to drive various machines. So its importance is to drive machines and to provide light. And maybe I should continue a bit more, that solar, compared to regular TANESCO electricity, has many benefits. Solar systems don't harm the environment…it doesn't have negative effects for the environment. And the cost is fairly low…When you buy it it's a fairly high price but you don't have a monthly bill. That is the second important aspect. But the third important aspect is why many people use it: solar systems can go where the state's electricity can't go.

Me: Na ile njia ya tatu, hizo seminar, zinawafundisha watu matumizi sahihi. Kwa hiyo naomba unielezee matumizi sahihi.
S: Huku kwetu huku sisi asilimia tisini ya watumiaji, pale mwanzo hawajui matumizi sahihi ya sola. Matokeo yake: wanapata hasara, labda kuua battery, au kutokupata matokeo sahihi kulingana nao ukubwa wa sola anayotumia. Kwa mfano, sola ina vitu vikubwa, nadhani unavifahamu, lakini nikirudia sio mbaya. Ina sola panel, battery, charger controller, inverter, ndio vitu vikubwa. Kwetu sisi kwa sola zinazokuja huku kwetu ndio hivyo. Sasa matumizi sahihi ni kwamba watu wengine hawajui matumizi sahihi ya inverter. Wengi hawajui matumizi sahihi ya charger controller. Kwa hiyo tunawaelimisha. Hawajui matumizi sahihi ya battery. Battery tunazotumia sisi ni za aina mbili. Battery ya acid, na battery kavu. Huku wanaiita battery kavu. Nadhani unazifahamu. Ile acid, wengi hiyo ndio changamoto kubwa. Wengi hawajui. Kwa hiyo unakuta amenunua sehemu nyingine ile ya acid, ameenda kutumia, anatumia vibaya, muda mfupi inaharibika. Anapata hasara kubwa wakati mwingine.

Me: And the third way, the seminars, they teach people proper uses of solar. So, please explain to me those proper uses.
S: Here in Tanzania, ninety percent of electricity users, there at the beginning they don't know proper uses of solar. Its results: they don't benefit. Maybe the battery dies, or they don't get the correct electricity compared to the size of the panel bought. For example, a solar system has large components, I think you know them, but to review isn't bad. It has a solar panel, a battery, a charge controller, and an inverter. Those are the big things. Here in Tanzania, the solar systems that come here are like this. Now, proper uses is that some people don't know proper uses of an inverter. Many don't know proper uses of a charge controller. So we educate them. They don't know proper uses of a battery. We use two types of batteries: Lead acid batteries and dry batteries. Here they call it a dry battery. I think you know them. The acid battery is a big challenge. Many people don't know it. So you find that someone has bought it somewhere, they go home and use it, they use it poorly, and after a short time it has already been damaged. Sometimes they don't benefit at all.

Mfano. Nakuta mtu amenunua battery ya acid ambapo kwa mara ya kwanza unaweka acid kama acid, na baadaye sio unaweka nini? Distilled water. Kwa hiyo sasa yeye, ananunua, anaweka acid kwa mara ya kwanza, baadaye anaendelea kuweka acid, acid, acid, acid…battery inakufa. Au ananunua battery ya acid, anawekewa hapo, anafungiwa, fundi anafunga vibaya… anafunga labda January. Anakaa mpaka August. Battery inakuwa imekauka kabisa. Inakufa. Kwa hiyo sasa tunachofanya ni kuenda kuwaelewesha sasa 'jamani ukinunua battery ya maji…kwenye matumizi yake sahihi ni hayo. Ukae mieze miwili ndio unaangalia kama maji imepungua unaongeza. Unaongeza distilled water na sio acid tena. Unafanya hivyo. Saa zingine, wakati mwingine, ile battery terminals zile zinaform carbon. Unaosha, unaita mtu fundi anasafisha kuondoa ile carbon, na vitu kama hivyo.

For example. You'll find that a person has bought an acid battery, and in the beginning, they fill it with acid. After that what are they supposed to fill it with? Distilled water. So now they buy it, fills it with acid in the beginning, and later they continue to fill it with acid, acid, acid, acid, and they the battery dies. Or they buy an acid battery, someone installs it for them, the technician installs it poorly…they install it in January. It sits until August. The battery has dried out completely. It dies. So what we do is to go to educate people, 'people, if you buy an acid battery… these are the proper uses. You stay for a few months to look if the acid lowers, you add distilled water, not acid. You do that.' Other times, carbon forms on the battery's terminals. You wash it, you call an engineer who cleans off the carbon. Things like that.